

AUTOMOTIVE INDUSTRY STANDARD

**Electric Vehicle Conductive
AC Charging System**

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ON BEHALF OF
AUTOMOTIVE INDUSTRY STANDARDS COMMITTEE

UNDER
CENTRAL MOTOR VEHICLE RULES – TECHNICAL STANDING COMMITTEE

SET-UP BY
MINISTRY OF ROAD TRANSPORT & HIGHWAYS
(DEPARTMENT OF ROAD TRANSPORT & HIGHWAYS)
GOVERNMENT OF INDIA

February 2017

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| General remarks : | | | | | | |

INTRODUCTION

The Government of India felt the need for a permanent agency to expedite the publication of standards and development of test facilities in parallel when the work of preparation of standards is going on, as the development of improved safety critical parts can be undertaken only after the publication of the standard and commissioning of test facilities. To this end, the erstwhile Ministry of Surface Transport (MoST) has constituted a permanent Automotive Industry Standards Committee (AISC) vide order no. RT-11028/11/97-MVL dated September 15, 1997. The standards prepared by AISC will be approved by the permanent CMVR Technical Standing Committee (CTSC). After approval, The Automotive Research Association of India, (ARAI), Pune, being the secretariat of the AIS Committee, has published this standard. For better dissemination of this information, ARAI may publish this standard on their website.

Under National Electric Mobility Mission Plan (NEMMP) - FAME scheme introduced by Department of Heavy Industry, Govt. of India envisages Faster Adaption and Manufacturing of Electric (EV) and Hybrid Electric Vehicles (HEV) in the country. This will need infrastructure support in terms of AC and DC charging stations.

This standard prescribes the specifications for performance and safety for AC charging Stations for EV and HEV application for Indian conditions.

While preparing this standard considerable assistance has been derived from following regulations.

| | |
|--------------|---|
| IEC 61851-1 | Electric vehicle conductive charging system - Part 1: General Requirements |
| IEC 61851-21 | Electric vehicle requirements for conductive connection to an AC /DC supply |
| IEC 61851-22 | Requirements for AC electric vehicle charging stations for conductive connection. |

The Panel and the Automotive Industry Standards Committee (AISC) responsible for preparation of this standard are given in Annex-I and Annex-J respectively.

Electric Vehicle Conductive AC Charging System

| Para. No | Contents | | Page. No. |
|----------|--|---|-----------|
| 1 | Scope | | 1/57 |
| 2 | References | | 1/57 |
| 3 | Terms and definitions | | 4/57 |
| 4 | General requirements | | 8/57 |
| 5 | Rating of the supply a.c. voltage | | 8/57 |
| 6 | General system requirement and interface | | 8/57 |
| | 6.1 | General description | 8/57 |
| | 6.2 | EV charging modes | 9/57 |
| | 6.2.1 | AC Slow Charging Mode | 9/57 |
| | 6.2.2 | AC Fast Charging Mode | 10/57 |
| | 6.3 | Extension Sets and Adapters | 10/57 |
| | 6.3.1 | Cord extension set | 10/57 |
| | 6.3.2 | Adaptors | 10/57 |
| | 6.4 | Safety Functions provided in Electric Vehicle Supply Equipment (EVSE)-AC | 10/57 |
| | 6.4.1 | Details of Mandatory Safety Functions | 11/57 |
| | 6.4.2 | Details of Optional Safety functions | 11/57 |
| | 6.4.3 | Details of pilot function | 12/57 |
| | 6.4.4 | Details of Proximity function | 12/57 |
| | 6.5 | Vehicle Identification Functions provided in EVSE-AC | 12/57 |
| | 6.6 | Energy Metering Functions provided in EVSE-AC | 12/57 |
| | 6.7 | Functions related to Communication to Grid | 12/57 |
| 7.0 | Protection against electric shock | | 13/57 |
| | 7.1 | General requirements | 13/57 |
| | 7.2 | Protection against direct contact | 13/57 |
| | 7.2.1 | General | 13/57 |
| | 7.2.2 | Accessibility of live parts | 13/57 |
| | 7.2.3 | Stored energy – discharge of capacitors | 13/57 |
| | 7.3 | Fault protection | 14/57 |
| | 7.4 | Supplementary measures | 14/57 |
| | 7.5 | Additional requirements | 14/57 |
| 8.0 | Connection between the EVSE and the EV | | 14/57 |
| | 8.1 | General | 14/57 |
| | 8.2 | Contact sequencing for AC Fast Charging | 15/57 |
| 9 | Specific requirements for vehicle inlet, connector, plug and socket-outlet | | 15/57 |

| | | | |
|----|--------------------------------------|--|-------|
| | 9.1 | General requirements | 15/57 |
| | 9.2 | Operating temperature | 15/57 |
| | 9.3 | Service life of inlet/connector and plug/socket-outlet | 15/57 |
| | 9.4 | Breaking capacity | 15/57 |
| | 9.5 | IP degrees | 16/57 |
| | 9.6 | Insertion and extraction force | 16/57 |
| | 9.7 | Latching of the retaining device | 16/57 |
| 10 | Charging cable assembly requirements | | 16/57 |
| | 10.1 | Electrical rating | 16/57 |
| | 10.2 | Electrical characteristics | 16/57 |
| | 10.3 | Dielectric withstand characteristics | 16/57 |
| | 10.4 | Mechanical characteristics | 16/57 |
| 11 | EVSE requirements | | 16/57 |
| | 11.1 | General test requirements | 16/57 |
| | 11.2 | Standard conditions for operation in service and for installation | 17/57 |
| | 11.3 | Classification | 17/57 |
| | 11.4 | IP degrees for EVSE | 17/57 |
| | 11.4.1 | IP degrees for ingress of objects | 17/57 |
| | 11.4.2 | Protection against electric shock | 18/57 |
| | 11.5 | Functional and constructional requirements | 18/57 |
| | 11.5.1 | Control functions | 18/57 |
| | 11.5.2 | Emergency service | 18/57 |
| | 11.5.3 | Permissible surface temperature | 18/57 |
| | 11.5.4 | Storage means for the cable assembly | 18/57 |
| | 11.5.5 | Location of the socket-outlet and storage means for the connector | 19/57 |
| | 11.6 | Dielectric withstand characteristics | 19/57 |
| | 11.6.1 | Dielectric withstand voltage | 19/57 |
| | 11.6.2 | Impulse dielectric withstand (1,2/50 IJS) | 19/57 |
| | 11.7 | Insulation resistance | 20/57 |
| | 11.8 | Clearances and creepage distances | 20/57 |
| | 11.9 | Leakage – touch current | 20/57 |
| | 11.10 | Electrical safety | 21/57 |
| | 11.10.1 | Protection against indirect contact | 21/57 |
| | 11.10.2 | Earthing electrode and continuity | 21/57 |
| | 11.10.3 | Detection of the electrical continuity of the protective conductor | 21/57 |
| | 11.11 | Environmental tests | 21/57 |

| | | | |
|----------|--|-------------------------------------|-------|
| | 11.11.1 | Climatic environmental tests | 21/57 |
| | 11.11.2 | Mechanical environmental tests | 26/57 |
| | 11.11.3 | Electromagnetic environmental tests | 28/57 |
| 11.12 | Latching of the retaining device | | 32/57 |
| 11.13 | Service | | 32/57 |
| 11.14 | Marking and instructions | | 32/57 |
| | 11.14.1 | Connection instructions | 33/57 |
| | 11.14.2 | Legibility | 33/57 |
| | 11.14.3 | Marking of EVSE - AC | 33/57 |
| | 11.15 | Telecommunication network | 33/57 |
| ANNEX A: | Pilot function through a control pilot circuit using PWM modulation and a control pilot wire | | 34/57 |
| ANNEX B: | Example of a circuit diagram for a basic vehicle coupler | | 41/57 |
| ANNEX C: | Connectors for AC Slow Charging and AC Fast Charging | | 45/57 |
| ANNEX D: | Cable Assembly for AC Slow Charging and AC Fast Charging | | 47/57 |
| ANNEX E: | EVSE Categories Based On Load Capacity | | 51/57 |
| ANNEX F: | Power Converters (AC to DC) | | 52/57 |
| ANNEX G: | Periodic Compliance of EVSE | | 53/57 |
| ANNEX H: | Technical information to be submitted by component manufacturer. | | 54/57 |
| ANNEX I: | Composition of AISC Panel | | 55/57 |
| ANNEX J: | Committee Composition | | 57/57 |

Electric Vehicle Conductive AC Charging System

1.0 SCOPE

This standard applies to charging electric road vehicles at standard a.c. supply voltages (as per IS 12360/IEC 60038) up to 1000 V and for providing electrical power for any additional services on the vehicle if required when connected to the supply network.

Electric road vehicles (EV) implies all road vehicles (2/3/4 Wheelers), including plug in hybrid road vehicles (PHEV), that derive all or part of their energy from on-board batteries.

The aspects covered include characteristics and operating conditions of the supply device and the connection to the vehicle, operators and third party electrical safety, and the characteristics to be complied with by the vehicle with respect to the EVSE-AC, only when the EV is earthed.

Requirements for specific inlet, connector, plug and socket-outlets for EVs are referred in AIS-038(Rev.1). This standard does not cover all safety aspects related to maintenance.

This standard is not applicable to trolley buses, rail vehicles and off-road industrial vehicles.

2.0 REFERENCES

The following referenced documents are indispensable for the application of this document.

For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

| | |
|---|---|
| IEC 61851 – 1 | Electric vehicle conductive charging system Part 1: General requirements. |
| IEC 61851 – 22 | Electric vehicle conductive charging system Part 22: AC electric vehicle charging station. |
| IS 12360:1988/ IEC 60038:2009 | Voltage bands for electrical installations including preferred voltages and frequency. |
| IEC 60068-2-30:2005 | Environmental testing – Part 2-30: Tests – Test Db: Damp heat, cyclic (12 + 12 h cycle). |
| IS 9000(Part 7/Sec 7):2006/ IEC 60068-2-75:1997 | Basic environmental testing procedures for electronic and electrical items: Part 7: Test Impact, Sec 7 Test Eh: Hammer tests. |
| IS 9000 (Part 4): 2008/ IEC 60068-2-78:2001 | Basic environmental testing procedures for electronic and electrical items: Part 4 DAMP HEAT (STEADY STATE). |

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| IS/IEC 60309 (Part 1): 2002/ IEC 60309-1:1999 | Plugs, socket outlets and couplers for industrial purpose Part 1 General requirements. |
| IS/IEC 60309-2:1999/ IEC 60309-2:1999 | Plugs, socket-outlets and couplers for industrial purposes – Part 2: Dimensional interchangeability requirements for pin and contact-tube accessories. |
| SP 30: 2011 | National Electrical Code (first revision) |
| IEC 60364-4-41:2005 | Low-voltage electrical installations – Part 4-41: Protection for safety – Protection against electric shock. |
| IS/IEC 60529: 2001 | Degrees of protection provided by enclosures (IP Code). |
| IS 15382 (Part 1): 2014/ IEC 60664-1:2007 | Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests. |
| IEC/TR 60755:2008 | General requirements for residual current operated protective devices |
| IS 1293:2005/ IEC 60884-1:2002 | Plugs and socket-outlets for household and similar purposes – Part 1: General requirements. |
| IEC 60884-2-5:1995 | Plugs and socket-outlets for household and similar purposes – Part 2 particular requirements for adaptors. |
| IEC 60947-3:2008 | Low-voltage switchgear and control gear – Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units. |
| IS 13252 (Part 1): 2010/ IEC 60950-1:2005 | Information technology equipment — Safety — Part 1: General requirements. |
| IS/IEC 60990: 1999 | Methods of measurement of touch current and protective conductor current. |
| IS 14700 (Part 6/Sec 1)/ IEC 61000-6-1:2005 | Electromagnetic compatibility (EMC) – Part 6-1: Generic standards – Immunity for residential, commercial and light-industrial environments. |
| IS 14700 (Part 6/Sec 3)/ IEC 61000-6-3:2006 | Electromagnetic compatibility (EMC) – Part 6-3: Generic standards – Emission standard for residential, commercial and light-industrial environments. |
| IEC 61008-1:2010 | Residual current operated circuit-breakers without integral overcurrent protection for household and similar uses (RCCBs) – General rules. |
| IEC 61009-1:2010 | Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBOs) – General rules. |

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|--|--|
| IEC 61180-1:1992 | High-voltage test techniques for low-voltage equipment – Part 1: definitions, test and procedure requirements. |
| IEC 62196-1:2003 | Plugs, socket-outlets, vehicle couplers and vehicle inlets – Conductive charging of electric vehicles Part 1: Charging of electric vehicles up to 250 A a.c. and 400 A d.c. |
| ISO 6469-2:2009 | Electrically propelled road vehicles – Safety specifications – Part 2: Vehicle operational safety means and protection against failures. |
| ISO 6469-3:2001 | Electric road vehicles – Safety specifications – Part 3: Protection of persons against electric hazards. |
| EN 50065-1:2001 | Signalling on low-voltage electrical installations in the frequency range 3 kHz to 148.5 kHz – Part 1: General requirements, frequency bands and electromagnetic disturbances. |
| IS 9000 (Part 2): 1977 / IEC 60068-2-1:1990 | Environmental testing- Part 2: Tests - Tests A: Cold. |
| IS 9000 (Part 3/ sec 1): 1977/ IEC 60068-2-2:1974 | Environmental testing- Part 2: Tests- Tests 8: Dry heat. |
| IS 9000 (Part 4): 1979/ IEC 60068-2-3:1969 | Environmental testing-Part 2: Tests- Test Ca: Damp heat, steady state. |
| IS 9000 (Part 17): 1985 / IEC 60068-2-5:1975 | Environmental testing-Part 2: Tests- Test Sa: Simulated solar radiation at ground level. |
| IS 9000 (Part 14/Sec 2): 1988 /IEC 60068-2-14:1984 | Environmental testing- Part 2: Tests- Test N: Change of temperature. |
| IS 9000 (Part 5/Sec 1): 1981/ IEC 60068-2-30:1980 | Environmental testing - Part 2: Tests- Test Db and guidance: Damp heat, cyclic (12 + 12-hour cycle) |
| IEC 60068-2-52:1996 | Environmental testing - Part 2: Tests - Test Kb: Salt mist, cyclic (sodium chloride solution) |
| IS 9000(Part 7/Sec 7): 2006 / IEC 60068-2-75:1997 | Environmental testing- Part 2: Tests - Test Eh: Hammer tests |
| IEC 61000-2-2:1990 | Electromagnetic compatibility (EMC) - Part 2: Environment - Compatibility levels for low-frequency conducted disturbances and signaling in public low-voltage power supply systems |

| | |
|---|---|
| IEC 61000-3-2:2000 | Electromagnetic compatibility (EMC) - Part 3-2: Limits - Limits for harmonic current emissions (equipment input current: 516 A per phase) |
| IS 14700 (Part 4/Sec 1): 1999 / IEC 61000-4-1:2000 | Electromagnetic compatibility (EMC) - Part 4-1: Testing and measurement techniques - Overview of IEC 61000-4 series |
| IEC 61000-4-2:1995 | Electromagnetic compatibility (EMC) - Part 4-2: Testing and measurement techniques - Section 2: Electrostatic discharge immunity test - Basic EMC publication 2) with Amendment 1 (1998) and Amendment 2 (2000) |
| IS 14700 (Part 4/Sec 3) / IEC 61000-4-3:1995 | Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques - Section 3: Radiated, radio-frequency, electromagnetic field immunity test 3) with Amendment 1 (1998) and Amendment 2 (2000) |
| IS 14700 (Part 4/Sec 4): 1999 / IEC 61000-4-4:1995 | Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques - Section 4: Electrical fast transient/burst immunity test - Basic EMC publication Amendment 1 (2000) |
| IS 14700 (Part 4/Sec 5) / IEC 61000-4-5:1995 | Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques - Section 5: Surge immunity test |
| IS 14700(Part 4: Sec 11):2008 / IEC 61000-4-11:1994 | Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques - Section 11: Voltage dips, short interruptions and voltage variations immunity tests |
| IEC 61180-1:1992 | High-voltage test techniques for low-voltage equipment - Part 1: Definitions, test and procedure requirements |
| CISPR 16 {all parts} | Specification for radio disturbance and immunity measuring apparatus and methods |
| CISPR 22:1997 | Information technology equipment- Radio disturbance characteristics- Limits and methods of measurement |

3.0 TERMS AND DEFINITIONS

For the purposes of this standard, the following terms and definitions apply.

- 3.1 **“Basic insulation”** Insulation of hazardous-live-parts which provides basic protection.
- 3.2 **“Cable assembly”** Piece of equipment used to establish the connection between the EV and socket-outlet or to the fixed charger.

NOTE 1: It must be included in the EVSE or detachable (supplied with the vehicle).

NOTE 2: It includes the flexible cable and the connector and/or plug that are required for proper connection.

NOTE 3: A detachable cable assembly is not considered as a part of the fixed installation.

- 3.3 **“Charger”** Power converter that performs the necessary functions for charging a battery.
- 3.3.1 **“Class I charger”** Charger with basic insulation as provision for basic protection and protective bonding as provision for fault protection.
- NOTE: Protective bonding consists of connection of all exposed conductive parts to the charger earth terminal.
- 3.3.2 **“Class II charger”** Charger with:
- Basic insulation as provision for basic protection, and
 - Supplementary insulation as provision for fault protection, or in which
 - Basic and fault protection are provided by reinforced insulation.
- 3.3.3 **“Off-board charger”** Charger connected to the premises wiring of the a.c. supply network (mains) and designed to operate entirely off the vehicle. In this case, direct current electrical power is delivered to the vehicle.
- 3.3.3.1 **“Dedicated off-board charger”** Off-board charger designed to be used only by a specific type of EV, which may have control charging functions and/or communication.
- 3.3.4 **“On-board charger”** Charger mounted on the vehicle and designed to operate only on the vehicle.
- 3.4 **“Charging”** All functions necessary to condition standard voltage and frequency AC supply current to a regulated voltage/current level to assure proper charging of the EV traction battery and/or supply of energy to the EV traction battery bus, for operating on-board electrical equipment in a controlled manner to assure proper energy transfer.
- 3.4.1 **“AC Slow Charging”** Charging with 1 Phase, 15 A Outlet with connector IEC 60309 and related safety interlocks. For details refer 6.2.1.
- 3.4.2 **“AC Fast Charging”** Charging with 3 Phase, 63 A Outlet with connector IEC 62196 and related safety interlocks. For details refer 6.2.2.
- 3.5 **“Connection”** Single conductive path.
- 3.6 **“Control pilot”** Control pilot is the control conductor in the cable assembly connecting the in-cable control box or the fixed part of the EVSE, and the EV earth through the control circuitry on the vehicle. It may be used to perform several functions.
- 3.7 **“Protective Earth (PE) terminal”** Accessible connection point for all exposed conductive parts electrically bound together.
- 3.8 **“Electric vehicle/ EV/ Electric road vehicle (ISO)”** Any vehicle propelled by an electric motor drawing current from a rechargeable storage battery or from other portable energy storage devices (rechargeable, using energy from a source off the vehicle such as a residential or public electric service), which is manufactured primarily for use on public streets, roads or highways.

- 3.8.1 **“Class I EV”** An EV with basic insulation as provision for basic protection and protective bonding as provision for fault protection.
NOTE: This consists of connection of all exposed conductive parts to the EV earth terminal.
- 3.8.2 **“Class II EV”** An EV in which protection against electric shock does not rely on basic insulation only, but in which additional safety precautions, such as double insulation or reinforced insulation, are provided, there being no provision for protective earthing or reliance upon installation conditions.
- 3.9 **“EV supply equipment / EVSE”** Conductors, including the phase, neutral and protective earth conductors, the EV couplers, attachment plugs, and all other accessories, devices, power outlets or apparatuses installed specifically for the purpose of delivering energy from the premises wiring to the EV and allowing communication between them if required.
- 3.9.1 **“EVSE AC”** All equipment for delivering a.c. current to EVs, installed in an enclosure(s) and with dedicated functions.
- 3.9.1.1 **“EVSE AC Slow”** EVSE that supports AC Slow type of charging as defined in 3.4.1.
- 3.9.1.2 **“EVSE AC Fast”** EVSE that supports AC Fast type of charging as defined in 3.4.2.
- 3.9.2 **“Exposed conductive part”** Conductive part of equipment, which can be touched and which is not normally live, but which can become live when basic insulation fails.
- 3.9.3 **“Direct contact”** Contact of persons with live parts.
- 3.9.4 **“Indirect contact”** Contact of persons with exposed conductive parts made live by an insulation failure.
- 3.10 **“Live part”** Any conductor or conductive part intended to be electrically energized in normal use.
- 3.10.1 **“Hazardous live part”** Live part, which under certain conditions, can result in an electric shock.
- 3.12 **“Plug and socket-outlet”** Means of enabling the manual connection of a flexible cable to fixed wiring.
NOTE: It consists of two parts: a socket-outlet and a plug.
- 3.12.1 **“Plug”** Part of a plug and socket-outlet integral with or intended to be attached to the flexible cable connected to the socket-outlet.
- 3.12.2 **“Socket-outlet”** Part of a plug and socket-outlet intended to be installed with the fixed wiring.
- 3.13 **“Power indicator”** Resistor value identifying supply rating recognition by the vehicle.
- 3.14 **“Retaining device”** Mechanical arrangement which holds a plug or connector in position when it is in proper engagement, and prevents unintentional withdrawal of the plug or connector.
- 3.15 **“Vehicle coupler”** Means of enabling the manual connection of a flexible cable to an EV for the purpose of charging the traction batteries.
NOTE: It consists of two parts: a vehicle connector and a vehicle inlet.

- 3.15.1 **“Vehicle connector”** Part of a vehicle coupler intended to be attached to the flexible cable connected to the a.c. supply network (mains).
- 3.15.2 **“Vehicle inlet”** Part of a vehicle coupler incorporated in, or fixed to, the EV or intended to be fixed to it.
- 3.16 **“Function”** Any means, electronic or mechanical, that insure that the conditions related to the safety or the transmission of data required for the mode of operation are respected.
- 3.17 **“Pilot function”** Any means, electronic or mechanical, that insures the conditions related to the safety or the transmission of data required for the mode of operation.
- 3.18 **“Proximity function”** A means, electrical or mechanical, in a coupler to indicate the presence of the vehicle connector to the vehicle.
- 3.19 **“Standardized socket-outlet for EVSE AC Slow”**
IEC 60309 Industrial connector (Refer Annex C for connector details)
- 3.20 **“Standardized socket-outlet for EVSE AC Fast”**
IEC 62196 Type 2 Connector (Refer Annex C for connector details)
- 3.21 **“Residual Current Device (RCD)”** Mechanical switching device designed to make, carry and break currents under normal service conditions and to cause the opening of the contacts when the residual current attains a given value under specified conditions.

NOTE 1: A residual current device can be a combination of various separate elements designed to detect and evaluate the residual current and to make and break current (IEC 60050-44:1998, 442-05-02).
- 3.22 **“Plug in Hybrid Electric road vehicle PHEV”** Any electrical vehicle that can charge the rechargeable electrical energy storage device from an external electric source and also derives part of its energy from another source.
- 3.23 **“Cord extension set”** Assembly consisting of a flexible cable or cord fitted with both a plug and a connector.

NOTE: Detachable cable assembly supplied with the vehicle is not considered as a cord extension set.
- 3.24 **“Adaptor”** A portable accessory constructed as an integral unit incorporating both a plug portion and one or more socket-outlets.
- 3.25 **“Indoor use”** Equipment designed to be exclusively used in weather protected locations.
- 3.26 **“Outdoor use”** Equipment designed to be allowed to be used in non-weather protected locations.
- 3.27 **“Mandatory Safety functions”** Mandatory Safety functions to be included in the EVSE. For details, refer 6.4.1.
- 3.28 **“Optional Safety functions”** Optional functions are functions that may enhance the performance or improve safety of the EVSE. For details, refer 6.4.2.

3.29 **“Extra Low Voltage”** Extra-low Voltage (ELV) voltage range should be considered as:

Voltage \leq 30 Vrms, 42.4 Vpk and 60 VDC; no risk of shock.

3.30 **“Hazardous Live Voltage”** Hazardous LIVE Voltage range should be considered as:

Voltage $>$ 30 Vrms, 42.4 Vpk and 60 VDC; risk of shock, burn, or fire.

3.31 **“Power Converter (AC to DC)”** A power Converter is an AC-DC Converter device connected in-line with charging connector Cable A to fulfil DC power requirements for charging of Electric Vehicles with maximum power rating of 1.1kW.

4.0 GENERAL REQUIREMENTS

The EV shall be connected to the EVSE so that in normal conditions of use, the conductive energy transfer function operates safely.

In general, this principle is achieved by fulfilling the relevant requirements specified in this standard, and compliance is checked by carrying out all relevant tests.

**Periodic compliance of EVSE is to be ensured by authorised agencies.

5.0 RATING OF THE SUPPLY A.C. VOLTAGE

The rated value of the a.c. supplied voltage for the charging equipment is up to 1000 V. The equipment shall operate correctly within ± 10 % of the standard nominal voltage. The rated value of the frequency is 50 Hz \pm 3%.

NOTE: Nominal voltage values can be found in IS 12360.

6.0 GENERAL SYSTEM REQUIREMENT AND INTERFACE

6.1 General description

One method for EV charging is to connect the a.c. supply network (mains) to an on-board charger. An alternative method for charging an EV is to use an off-board charger for delivering direct current. For charging in a short period of time, special charging facilities operating at high power levels could be utilized.

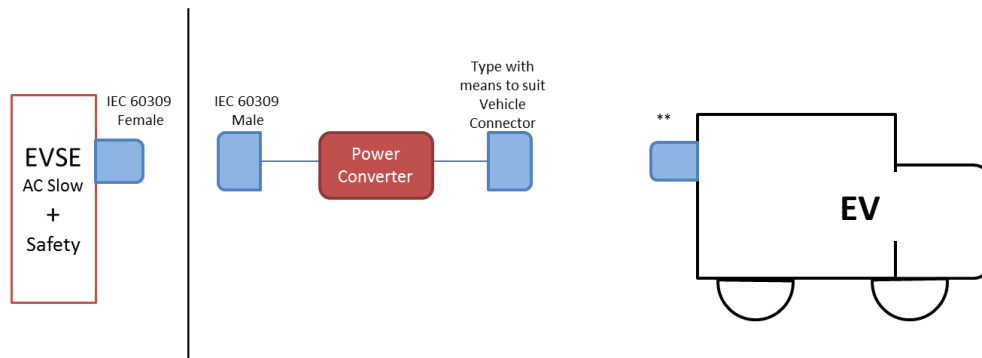
6.2 EV charging modes

6.2.1 AC Slow Charging Mode

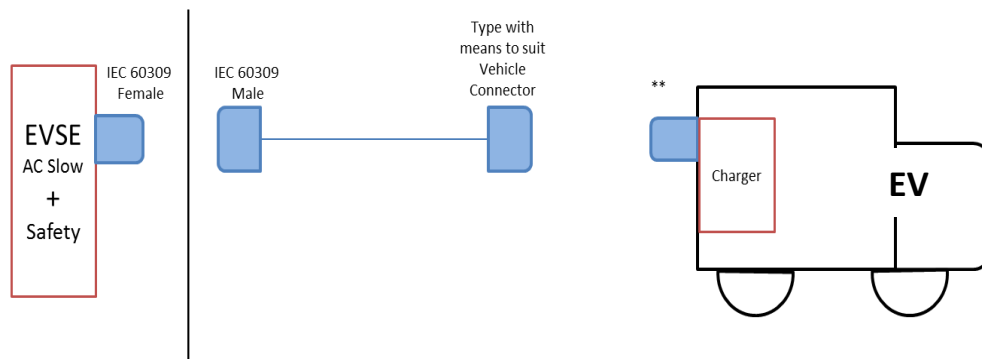
AC Connector Interface (Single Phase, 15 A)

Connection of the EV to the a.c. supply network (mains) utilizing Single Phase EVSE – AC Slow with Charging outlet IEC 60309 (Industrial Type) with ratings not exceeding 15 A and Nominal Voltage* +/- 10% utilizing the power and protective earth conductors, system of personnel protection against electric shock (RCD) and including mandatory safety functions (refer 6.4.1) as part of the EVSE - AC Slow.

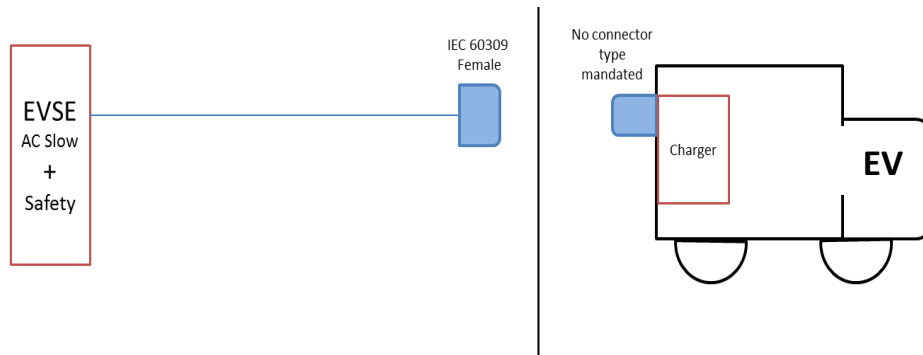
Output Option 1 (EV without On-Board Charger)



Output Option 2 (EV with On-Board Charger)



Output Option 3 (Cable attached to EVSE- AC Slow)



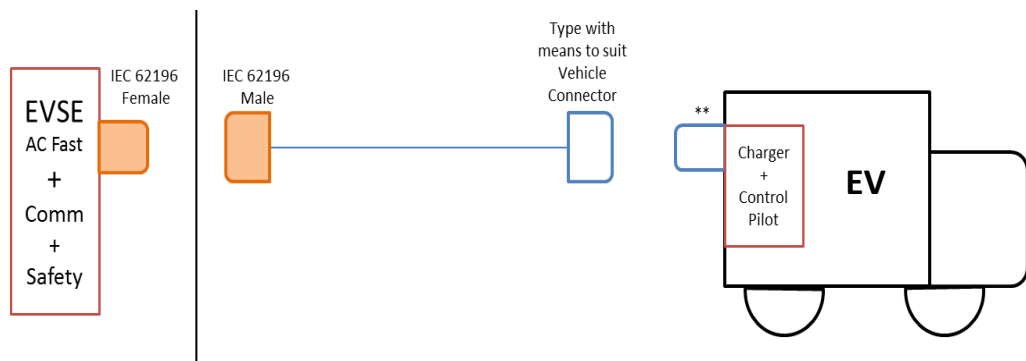
6.2.2 AC Fast Charging Mode

AC Connector Interface (3 Phase, 63A)

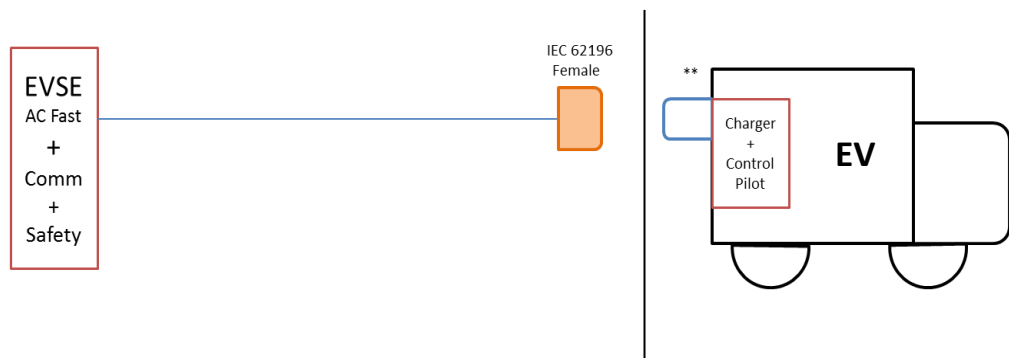
NOTE: * Refer IS 12360

Connection of the EV to the a.c. supply network (mains) utilizing EVSE - AC Fast with charging outlet IEC 62196 Type 2 with ratings not exceeding 63A and 415*V +/- 10% where the control pilot function extends to control equipment in the EVSE, permanently connected to the a.c. supply network (mains). Mandatory and optional safety functions (refer 6.4.2) are to be incorporated as a part of the EVSE – AC Fast.

Output Option 1 (Detachable Cable assembly)



Output Option 2 (Cable assembly integrated with EVSE)



NOTE **: Requirements for specific inlet, connector, plug and socket-outlets for EVs are referred in AIS-038 (Rev.1).

6.3 Extension Sets and Adapters

6.3.1 Cord extension set

A cord extension set or second cable assembly shall not be used in addition to the cable assembly for the connection of the EV to the EVSE. The cable assembly shall be so constructed that it cannot be used as a cord extension set.

6.3.2 Adaptors

Adaptors shall not be used to connect a vehicle connector to a vehicle inlet.

6.4 Safety Functions provided in EVSE-AC

In case of any fault, a visual indicator should be provided in EVSE.

6.4.1 **Details of Mandatory Safety Functions**

6.4.1.1 **Earth Presence Detection (Socket - EVSE)**

Validate the presence of earth at the AC socket outlet during start of charging session and continuous/periodic monitoring during the charging session.

6.4.1.2 **Earth Continuity Check (EVSE-EV)**

Presence of earth between EV and EVSE during charging session is to be monitored. In AC Slow Charging, this is to be ensured at the vehicle side.

6.4.1.3 **Over-voltage Protection**

The EVSE should have protection against Over-Voltage.

6.4.1.4 **Under-Voltage Protection**

The EVSE should have protection against Under-Voltage.

6.4.1.5 **Over Current and Short-Circuit Protection**

The EVSE should have protection against Over-Current and Short-Circuit.

6.4.1.6 **Leakage Current**

Fault or leakage current inside the EVSE is to be detected and protection is to be provided in case of detection. Type of RCD (Type A minimum) and Fault Current Limit 30 mA.

6.4.1.7 **Connector Presence & Locking**

It should be verified that the connector is properly connected and Connector is locked during charging period of the charge session to avoid accidental/unintentional disconnection. For AC Slow charging connector, this is to be ensured by physical attributes.

6.4.1.8 **Environmental Protection**

The EVSE should have protection against environmental conditions like Solar Radiation, Temperature, and Water.

Note: The protection against Environmental conditions will be checked under 11.4 and 11.11.

6.4.1.9 **Protection when Phase -Neutral Interchange occurs**

Charging function for vehicle may not be inhibited provided mandatory safety is fully functional even in case of Phase-Neutral interchange condition.

6.4.2 **Details of Optional Safety functions**

6.4.2.1 **Verification that the vehicle is properly connected**

The EVSE-AC Fast shall be able to determine that the connector is properly inserted in the vehicle inlet and properly connected to the EVSE. Vehicle movement by its own propulsion system shall be impossible as long as the vehicle is physically connected to the EVSE as required in ISO 6469-2.

6.4.2.2 **Energization of the system**

Energization of the system shall not be performed until the pilot function between EVSE and EV has been established correctly. Energization may also be subject to other safety conditions being fulfilled.

6.4.2.3 **De-energization of the system**

If the pilot function is interrupted, the power supply to the cable assembly shall be interrupted but the control circuit may remain energized.

6.4.2.4 **Input Power Quality**

Monitor the AC supply (Rated Power, Voltage and Frequency Tolerance) for possible faults and include necessary corrective measures.

6.4.2.5 **Fail Safe Handling**

Fail-safe operations should function when certain faults occur.

6.4.2.6 **Determination of ventilation requirements during charging**

If additional ventilation is required during charging, charging shall only be allowed if such ventilation is provided.

6.4.2.7 **Detection/adjustment of the real time available load current of EVSE**

Means shall be provided to ensure that the charging rate shall not exceed the real time available load current of the EVSE and its power supply.

6.4.2.8 **Retaining/releasing of the coupler**

A mechanical means shall be provided to retain/release the coupler.

6.4.2.9 **Selection of charging rate**

A manual or automatic means shall be provided to ensure that the charging rate does not exceed the rated capacity of the a.c. supply network (mains), vehicle or battery capabilities.

6.4.3 **Details of pilot function**

For AC Fast Charging mode, a pilot function is mandatory. The pilot function shall be capable of performing at least the mandatory safety functions described above and may be capable of performing/contributing in optional functions.

NOTE: For details of Pilot Function and relevant examples refer Annex A.

6.4.4 **Details of Proximity function**

For AC Fast Charging mode, Proximity function is mandatory.

NOTE: For implementation details Annex B can be referred.

6.5 **Vehicle Identification Functions provided in EVSE-AC**

Reserved

6.6 **Energy Metering Functions provided in EVSE-AC**

Reserved

6.7 **Functions related to Communication to Grid**

Reserved

7.0 PROTECTION AGAINST ELECTRIC SHOCK

7.1 General requirements

Hazardous live parts shall not be accessible. Exposed conductive parts shall not become a hazardous live part under normal conditions (operation as intended use and in the absence of a fault), and under single-fault conditions. Protection against electric shock is provided by the application of appropriate measures for protection both in normal service and in case of a fault. For systems or equipment on board the vehicle, the requirements are defined in AIS-038 (Rev.1) – For systems or equipment external to the vehicle, the requirements are defined in SP 30: 2011 /IEC 60364-4-41.

7.2 Protection against direct contact

7.2.1 General

Protection against direct contact shall consist of one or more provisions that under normal conditions prevent contact with hazardous-live parts. For systems or equipment on board the vehicle, the requirements are defined in AIS-038 (Rev.1).

Protective bonding shall consist of connection of all exposed conductive parts to the EV earth terminal.

7.2.2 Accessibility of live parts

When connected to the supply network, the EVSE shall not have any accessible hazardous live part, even after removal of parts that can be removed without a tool.

All accessible parts (eg. metal enclosures) must be prevented from becoming hazardous live. For details of Hazardous live Voltage refer Section 3.

Compliance is checked by inspection and according to the requirements of IS/IEC 60529 (IPXXB).

NOTE: Extra Low Voltage (ELV) auxiliary circuits which are galvanically connected to the vehicle body are accessible. Particular attention is drawn to the requirements for ELV circuit isolation when the traction battery is being charged using a non-isolated charger.

7.2.3 Stored energy – discharge of capacitors

7.2.3.1 Disconnection of EV

One second after having disconnected the EV from the supply (mains), the voltage between accessible conductive parts or any accessible conductive part and earth shall be less than or equal to 42,4 V peak, or 60 V D.C., and the stored energy available shall be less than 20 J (see IS 13252/IEC 60950). If the voltage is greater than 42,4 V peak (30 V rms) or 60 V D.C., or the energy is 20 J or more, a warning label shall be attached in an appropriate position.

Compliance is checked by inspection and by test.

7.2.3.2 Disconnection of EVSE

Conditions for the disconnections of the EVSE from the supply mains are identical to those required for the disconnection of the EV as indicated in 7.2.3.1.

7.3 **Fault protection**

Protection against indirect contact shall consist of one or more recognized provision(s).

According to SP 30: 2011 /IEC 60364-4-41, recognized individual provisions for fault protection are:

- Supplementary or reinforced insulation;
- Protective equipotential bonding;
- Protective screening;
- Automatic disconnection of supply;
- Simple separation.

7.4 **Supplementary measures**

To avoid indirect contact in case of failure of the basic and/or fault protection or carelessness by users, additional protection against electric shock shall be required.

An RCD ($I_{AN} < 30 \text{ mA}$) shall be provided as a part of the EV conductive supply equipment for earthed systems. The RCD shall have a performance at least equal to Type A and be in conformity with standard SP 30: 2011 /IEC 60364-4-41.

Where power supply circuits that are galvanically separated from mains and are galvanically isolated from earth, electrical isolation between the isolated circuits and earth, and between the isolated circuits and exposed conductive parts of vehicle and EVSE shall be monitored.

When a fault condition related to the electrical isolation is detected, the power supply circuits shall be automatically de-energized or disconnected by the EVSE.

7.5 **Additional requirements**

Under normal conditions, malfunction and single-fault conditions, the charging system shall be designed to limit the introduction of harmonic, D.C. and non-sinusoidal currents that could affect the proper functioning of residual current devices or other equipment.

Class II chargers may have a lead - through protective conductor for earthing the EV chassis.

8.0 CONNECTION BETWEEN THE EVSE AND THE EV

8.1 **General**

This clause provides a description of the physical conductive electrical interface requirements between the vehicle and the EVSE.

| Contact Number | IEC 60309 | IEC 62196 | Function |
|----------------|--------------------|-------------------|----------|
| 1 | Single Phase, 15 A | Three Phase, 63 A | L1 |
| 2 | | Three Phase, 63 A | L2 |
| 3 | | Three Phase, 63 A | L3 |

| | | | |
|---|--------------------|-------------------|---------------|
| 4 | Single Phase, 15 A | Three Phase, 63 A | Neutral |
| 5 | Rated for fault | Rated for Fault | PE |
| 6 | | | Control Pilot |
| 7 | | | Proximity |
| For details, refer Annex C and Annex D. | | | |

8.2 **Contact sequencing for AC Fast Charging**

For safety reasons, the contact sequence during the connection process shall be such that the earth connection is made first and the pilot connection is made last. The order of connection of the other contacts is not specified. During disconnection, the pilot connection shall be broken first and the earth connection shall be broken last.

9.0 **SPECIFIC REQUIREMENTS FOR VEHICLE INLET, CONNECTOR, PLUG AND SOCKET-OUTLET**

9.1 **General requirements**

The requirements for accessories for AC Slow charging are specified in IS/IEC 60309-1, IS/IEC 60309-2 (industrial type).

The requirements of EVSE systems for AC Fast Charging are specified in IEC 62196-1.

9.2 **Operating temperature**

The EVSE-AC should be fully functional with all safety features in the temperature range of 0 to 55°C.

9.3 **Service life of inlet/connector and plug/socket-outlet**

The requirements for accessories of the standard interface are specified in IS/IEC 60309-1, IS/IEC 60309-2 (industrial type).

The requirements for accessories of the interface are specified in IEC 62196-1.

9.4 **Breaking capacity**

The requirement for AC Slow Charging shall be in accordance with IEC 60309.

The requirement for AC Fast Charging shall be in accordance with IEC 62196-1.

For personal safety and to avoid damage due to disconnection under nominal current, the plug, the inlet, the connector or the socket-outlet shall have sufficient breaking capacity unless there is a switch with sufficient breaking capacity. Acceptable breaking capacity is reached by breaker level for a.c. application AC22A as defined in IS/IEC 60947-3, or breaker level for a.c. application AC2 as defined in IS/ IEC 60947-6.

Avoidance of breaking under load can be achieved by a specific means on the connector or a system with interlock.

9.5 **IP degrees**

IP degrees for accessories are treated in 11.3.

9.6 **Insertion and extraction force**

The force required for connecting and disconnecting operations for the connector and inlet is in accordance with IEC 60309 for AC Slow Charging and IEC 62196-1 for AC Fast Charging.

9.7 **Latching of the retaining device**

Latching or retaining if required may be a function of the complete system or the connector.

10.0 **CHARGING CABLE ASSEMBLY REQUIREMENTS**

10.1 **Electrical rating**

The rated voltage of each conductor shall correspond to the rated voltage of the connecting means. The rated current shall correspond to the rating of the line circuit breaker.

10.2 **Electrical characteristics**

The voltage and current ratings of the cable shall be compatible with those of the charger.

The cable may be fitted with an earth-connected metal shielding. The cable insulation shall be wear resistant and maintain flexibility over the full temperature range.

For details, refer Annex D.

10.3 **Dielectric withstand characteristics**

Dielectric withstand characteristics shall be as indicated for the EVSE in 11.4.

10.4 **Mechanical characteristics**

The mechanical characteristics of the cable should be equivalent or superior to those of IS 9857 / IEC 60245-6 (Welding cable) as well as for fire resistance, chemical withstand, UV resistance.

The anchorage force of the cable in the connector or plug shall be greater than the retaining device force, if used.

For details, refer Annex D

11.0 **EVSE REQUIREMENTS**

11.1 **General test requirements**

- All tests in this standard are type tests.
- Unless otherwise specified, type tests shall be carried out on a single specimen as delivered and configured in accordance with the manufacturer's instructions.
- The tests in 11.12 may be conducted on separate samples at the discretion of the manufacturer. Unless otherwise specified, all other tests shall be carried out in the order of the clauses and sub clauses in this part.
- The tests shall be carried out with the specimen, or any movable part of it, placed in the most unfavourable position which may occur in normal use.
- Unless otherwise specified, the tests shall be carried out in a draught-free

location and at an ambient temperature of 20 to 30 °C.

NOTE: For details, refer IEC 61851 – 22.

11.2 **Standard conditions for operation in service and for installation**

The rated value of the a.c. supply voltage is up to 1000 V. The equipment shall operate correctly within $\pm 10\%$ of the standard nominal voltage (see IS 12360). The rated value of the frequency is 50 Hz $\pm 3\%$.

The operating temperature range during charging may be between 0 to 55 °C and at a relative humidity of between 5 % and 95 %.

11.3 **Classification**

EVSE - AC shall be classified according to exposure to environmental conditions:

- Outdoor use;
- Indoor use.

NOTE: EVSEs classified for outdoor use can be used for indoor use, provided ventilation requirements are satisfied.

11.4 **IP degrees for EVSE**

11.4.1 **IP degrees for ingress of objects**

Compliance is checked by test in accordance with IS/IEC 60529.

The minimum IP degrees for ingress of object and liquids shall be:

Indoor use:

- Vehicle inlet mated with connector: IP21,
- Plug mated with socket outlet: IP21,
- Connector for Cable assembly integrated with EVSE, when not mated, indoor: IP21.

Outdoor use:

- Vehicle inlet mated with connector: IP44,
- Plug mated with socket outlet: IP44.

All cable assemblies shall meet outdoor requirements.

- EV inlet in "road" position: IP55.
- Connector when not mated: IP24,
- Socket-outlet when not mated: IP24.

NOTE 1: IPX4 may be obtained by the combination of the socket-outlet or connector and the lid or cap, EVSE - AC enclosure, or EV enclosure.

NOTE 2: EV inlet protection may be obtained by the combination of the inlet and vehicle design.

11.4.2 **Protection against electric shock**

- Vehicle inlet mated with connector: IPXXD;
- Plug mated with socket outlet: IPXXD;

- Connector intended for AC Slow Charging : IPXXD ;
- Connector intended for AC Fast Charging: IPXXB;
- Socket-outlet not mated: IPXXD (1).
- Energy transfer from vehicle to grid:
- Vehicle inlet not mated: IPXXD (2);
- Plug not mated: IPXXD (2).

Compliance is checked with the accessory in the installed position.

- (1) Equivalent protection to IPXXD may also be obtained with IPXXB accessories if an isolating function is used according SP 30: 2011 /IEC 60364-4-41.
- (2) Equivalent protection to IPXXD may also be obtained with IPXXB accessories if an isolating function is used on the vehicle according to requirements described in AIS-038 (Rev.1).

11.5 **Functional and constructional requirements**

11.5.1 **Control functions**

For AC Fast charging, the EVSE Fast charger provides part of the control functions listed in 6.4.

11.5.2 **Emergency service**

An emergency disconnection device shall be installed to isolate the a.c. supply network (mains) from the EVSE - AC in case of risk of electric shock, fire or explosion. The disconnection device shall be provided with a means to prevent accidental operation.

11.5.3 **Permissible surface temperature**

The maximum permissible surface temperature of parts of the EVSE – AC which are hand grasped, at the maximum rated current and at an ambient temperature of 40 °C, shall be

50 °C for metal parts;

60 °C for non-metallic parts.

For parts which may be touched but not grasped, maximum permissible surface temperature under the same conditions shall be

60 °C for metal parts;

85 °C for non-metallic parts.

11.5.4 **Storage means for the cable assembly**

For AC Fast charging output option-2 (refer 6.2.2) connections, a storage means shall be provided for the cable assembly and vehicle connector when not in use. The EVSE – AC Fast should be provided with a means to indicate whether or not the cable assembly/vehicle connector has been stored as intended after disconnection from the vehicle.

11.5.5 Location of the socket-outlet and storage means for the connector

The lowest part of the socket-outlet (in output option 1 connections), or the storage means provided for the vehicle connector (in output option 2 connection), shall be located at a height between 0.4 m and 1.5 m above ground level in EVSE - AC Fast.

11.6 Dielectric withstand characteristics

11.6.1 Dielectric withstand voltage

The dielectric- withstand voltage at power frequency (50 Hz) shall be applied for 1 min as follows:

- a) For a class I a.c supply equipment
 - 2000 V r.m.s. in common and differential mode*
- b) For a class II a.c supply equipment
 - 4000 V r.m.s. in common mode (all circuits in relation to the exposed conductive part)
 - 2000 V r.m.s. in differential mode* (between each electrically independent circuit and all other exposed conductive part-oriented circuits)
- c) For both class I and class II a.c supply equipment
 - 4000 V r.m.s. between power circuits and extra low voltage circuits

The tests shall be carried out in accordance with the requirements of IEC 61180-1.

NOTE: *Differential testing is applicable for EVSE- AC fast only.

Compliance/ Acceptance Criteria

- Output voltage stability to be ensured after the test.
- Insulation resistance to be verified.
- Protection against output short circuit to be verified.

11.6.2 Impulse dielectric withstand (1,2/50 IJS)

The dielectric withstand of the power circuits at impulse shall be checked as follows:

6000 V: in common mode (according to IEC 60664-1 installation category);

4000 V: in differential mode* (according to IEC 60664-1 installation category).

The test shall be carried out in accordance with the requirements of IEC 61180-1.

NOTE: *Differential testing is applicable for EVSE- AC fast only.

Compliance/ Acceptance Criteria

- Output voltage stability to be ensured after the test.
- Insulation resistance to be verified.
- Protection against output short circuit to be verified.

11.7 Insulation resistance

The insulation resistance with a 500 V D.C. voltage applied between all inputs/outputs connected together (power source included) and the accessible parts shall be

For a class I station: $R \geq 1 \text{ MQ}$

For a class II station: $R \geq 7 \text{ MQ}$

The measurement of insulation resistance shall be carried out after applying the test voltage for 1 min and immediately after the damp heat test (see 11.1.4).

11.8 Clearances and creepage distances

Electrical devices installed in the charging stations shall have insulation spacing clearances and creepage distances complying with those specified in their relevant standards. For bare live conductors and terminations (for example, bus bars, connections between apparatus, etc.) clearances and creepage distances shall be chosen according to IEC 60664-1.

11.9 Leakage – touch current

The touch current shall be measured after the damp heat test (see 11.1.4), with the EVSE - AC connected to a.c. supply network (mains) in accordance with 5.1 of IEC 60950. The supply voltage shall be 1.1 times the nominal rated voltage.

The touch current between any a.c. supply network poles and the accessible metal parts connected with each other and with a metal foil covering insulated external parts, measured in accordance with IEC 60950, shall not exceed the values indicated in Table 2.

| Table 2- Touch current limits | | |
|--|----------------|-----------------|
| | Class I | Class II |
| Between any network poles and the accessible metal parts connected with each other and a metal foil covering insulated external parts | 3,5 mA | 0,25 mA |
| Between any network poles and the metal inaccessible parts normally non activated (in the case of double insulation) | Not applicable | 3,5 mA |
| Between inaccessible and accessible parts connected with each other and a metal foil covering insulated external parts (additional insulation) | Not applicable | 0,5 Ma |

This test shall be made when the EVSE – AC is functioning with a resistive load at rated output power.

NOTE: Circuitry which is connected through a fixed resistance or referenced to earth (for example, EV connection check) should be disconnected before this test.

The equipment is fed through an isolating transformer or installed in such a manner that it is isolated from the earth.

11.10 **Electrical safety**

The general requirements for electrical safety are specified in 7. In addition, the following requirements apply.

11.10.1 **Protection against indirect contact**

The protection against electric shock shall not be automatically reset. Manual reset shall be easily accessible to the user. Automatic reset of optional additional protection devices, as specified in 7, shall comply with national regulations.

11.10.2 **Earthing electrode and continuity**

The tests for a class I charging station earth electrode, where applicable, and earthing of the EVSE- AC shall be carried out in accordance with the national rules and safety requirements for earthing.

All exposed conductive parts of the EVSE - AC which could be connected to the supply voltage source, under fault conditions, shall be connected together in such a manner that they conduct electricity properly, so as to conduct potential fault currents to the earthed point of the a.c. supply network (mains).

Compliance is checked by testing the electrical continuity between exposed conductive parts and the earth circuit.

A current of 15 A, derived from a D.C. source having a no-load voltage not exceeding 12 V, is passed between any exposed conductive part and the earthing terminal of the charging station. For each exposed conductive part, the voltage drop is measured between these two points.

The resistance calculated from the current and measured voltage drop, between any exposed conductive part and the earth-circuit connection, shall not exceed 0.1 ohm.

For a class II charging station, there shall be a lead-through protective conductor.

11.10.3 **Detection of the electrical continuity of the protective conductor**

For AC Fast charging, the EVSE - AC Fast shall monitor the electrical continuity of the protective conductor to the electric vehicle. If the EVSE detects a loss of electrical continuity of the protective conductor, the electrical supply circuit to the vehicle shall be opened.

11.11 **Environmental tests**

11.11.1 **Climatic environmental tests**

11.11.1.1 **General**

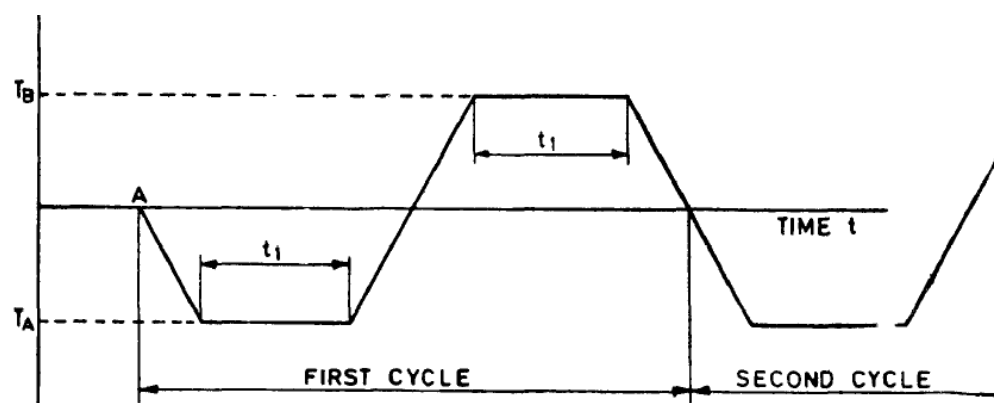
During the following tests, the EVSE - AC shall function at its nominal voltage with maximum output power and current. After each test, the original requirements shall still be met.

11.11.1.2 **Ambient air temperature**

The EVSE - AC shall be designed to operate within the temperature range 0 °C to +55 °C.

These tests shall be carried out in accordance with the Nb test (change of temperature with specified rate of change) of IEC 60068-2-14/ IS 9000 (Part 14) - sec 2.

Test Cycle



Test Parameters

| Parameter | Value | Unit |
|--------------------|-------|-------------------------------|
| Low temp T_A | 0 | $^{\circ}\text{C}$ |
| High temp T_B | +55 | $^{\circ}\text{C}$ |
| Rate of Temp (Max) | 1 | $^{\circ}\text{C}/\text{min}$ |
| Time t_1 | 1 | h |
| No of cycles | 2 | -- |

EVSE Condition

Power ON with output loading for maximum power and current.

EVSE Monitoring

Periodic measurements of output power and current during the test.

Compliance/ Acceptance Criteria

- Output power and current values to be within specified band
- Safety checks
 - To ensure protection against short circuit
 - To check the insulation resistance

11.11.1.3 Dry heat

The test shall be in accordance with IEC 60068-2-2 Bc or Bd test (dry heat)/ IS 9000 (Part 3) - sec 5.

Test Parameters

| Parameter | Value | Unit |
|-------------------|-------|--------------------|
| Temperature | 55 | $^{\circ}\text{C}$ |
| Relative humidity | <50 | % |

| | | |
|--------------------|----|--------|
| Rate of Temp (Max) | 1 | °C/min |
| Duration | 16 | h |

EVSE Condition

Power ON with output loading for maximum power and current.

EVSE Monitoring

Periodic measurements of output power and current during the test.

Compliance/ Acceptance Criteria

- Output power and current values to be within specified band
- Safety checks
 - To ensure protection against short circuit
 - To check the insulation resistance

11.11.1.4 **Ambient humidity**

The EVSE -AC shall be designed to operate with a relative humidity rate between 5 % and 95 %.

Damp heat cycle test

The test shall be carried out in accordance with IEC 60068-2-30/ IS 9000(Part 5 /Sec 2), test Db, at 55°C for six cycles.

Test Parameters

| Parameter | Value | Unit |
|--------------------|---------|--------|
| Temperature | 55 | °C |
| Relative humidity | 95 | % |
| Rate of Temp (Max) | 1 | °C/min |
| Duration | 12 + 12 | hours |
| No of cycles | 6 | |

EVSE Condition

Power ON with output loading for maximum power and current.

EVSE Monitoring

Periodic measurements of output power and current during the test.

Compliance/ Acceptance Criteria

- Immediately after damp heat within 1 min, Insulation Resistance test to be performed.
- Output power and current values to be within specified band.
- Safety checks to ensure protection against short circuit.

11.11.1.5 **Cold test**

The test shall be carried out in accordance with IEC 60068-2-1 test Ab/ IS 9000 (Part 2) - sec 3.

Test Parameters

| Parameter | Value | Unit |
|--------------------|-------|--------|
| Temperature | 0 | °C |
| Rate of Temp (Max) | 1 | °C/min |
| Duration | 16 | hours |

EVSE Condition

Power ON with output loading for maximum power and current.

EVSE Monitoring

Periodic measurements of output power and current during the test.

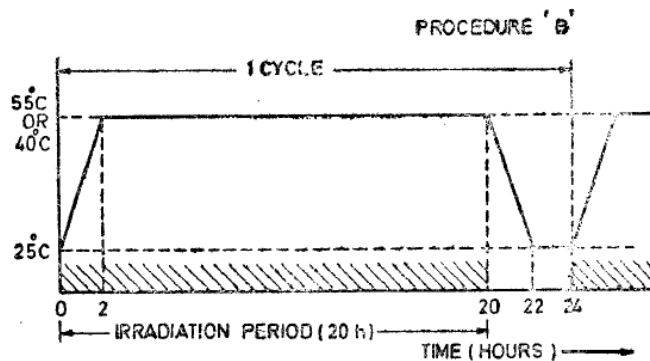
Compliance/ Acceptance Criteria

- Output power and current values to be within specified band.
- Safety checks
 - To ensure protection against short circuit
 - To check the insulation resistance

11.11.1.7 **Solar radiation**

The test shall be carried out in accordance with IEC 60068-2-5, test Sa, procedure B/ IS 9000(Part 17) procedure B.

Test Cycle



Test Parameters

| Parameter | Value | Unit |
|----------------------|-------|-------|
| Temperature low | 25 | °C |
| Temperature high | 55 | °C |
| Irradiation Duration | 20 | hours |
| Darkness duration | 4 | hours |
| No of cycles | 10 | |

EVSE Condition

Power ON with output loading for maximum power and current.

EVSE Monitoring

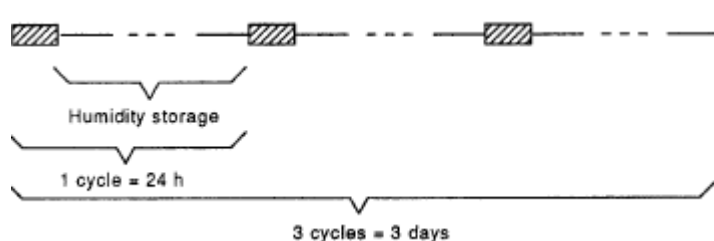
Measurements of output power and current during the test at extreme pressure conditions.

Compliance/ Acceptance Criteria

- Output power and current values to be within specified band.
- Safety checks
 - To ensure protection against short circuit
 - To check the insulation resistance

11.11.1.8 Saline mist

The tests shall be carried out in accordance with IEC 60068-2-52, Kb test-severity –Two.

Test Cycle

 = Spray period: 2 h

Test Parameters

| Parameter | Value | Unit |
|-------------------------|----------|------|
| Salt mist chamber temp. | 15 - 35 | °C |
| Spray Duration | 2 | h |
| Humidity chamber temp. | 40 +/- 2 | °C |
| Humidity | 93 | % |
| Humidity storage period | 20 - 22 | h |
| No of cycles | 3 | |

EVSE Condition

Power ON with output loading for maximum power and current.

EVSE Monitoring

Measurements of output power and current during the test at extreme pressure conditions.

Compliance/ Acceptance Criteria

- Insulation Resistance test to be performed immediately within 1 min after damp heat.
- Output power and current values to be within specified band.
- Safety checks to ensure protection against short circuit.

11.11.2 Mechanical environmental tests**11.11.2.1 General**

After the following tests, no degradation of performance is permitted.

Compliance is checked by verification after the test that

- 1) the IP degree is not affected;
- 2) the operation of the doors and locking points is not impaired;
- 3) the electrical clearances have remained satisfactory for the duration of the tests, and
- 4) for a charging station having a metallic enclosure, no contact between live parts and the enclosure has occurred, caused by permanent or temporary distortion.

For a charging station having an enclosure of insulating material, if the conditions above are satisfied, then damage such as small dents or small degrees of surface cracking or flaking are disregarded, provided that there are no associated cracks detrimental to the serviceability of the charging station.

11.11.2.2 Mechanical impact

The EVSE – AC body shall not be damaged by mechanical impact.

Compliance is checked according to the test procedure described in IEC 60068-2-75 (severity) / IS 9000(Part 7/Sec 7) - impact energy value 20 J (5 kg at 0.4 m).

11.11.2.3 Stability

The EVSE - AC shall be installed as intended by the manufacturer's installation instructions. A force of 500 N shall be applied for 5 min in the horizontal direction to the top of the EVSE - AC in each of the four directions or in the worst possible horizontal direction. There shall be neither deterioration of the a.c. Electric vehicle charging neither station nor deformation at its summit greater than

50 mm during the load application;

10 mm after the load application.

11.11.2.4 IP TESTING

The testing shall be carried out in accordance with IS/IEC 60529.

Atmospheric conditions for water or dust tests

| Parameter | Value | Unit | Reference |
|-------------------|-----------|------|-------------------------------|
| Temperature | 15 to 35 | °C | As given in the test standard |
| Relative humidity | 25 to 75 | % | |
| Air pressure | 86 to 106 | kPa | |

For EVSE-AC IP for Outdoor applications: IP 54**Test means and main test conditions for the tests for protection against dust**

Dust chamber (Test device to verify protection against dust): As per test standard.

Talcum powder: As per test standard.

Category 2 Enclosures: Enclosures where no pressure difference relative to the surrounding air is present.

The enclosure under test is supported in its normal operating position inside the test chamber, but not connected to a vacuum pump. Any drain-hole normally open shall be left open for the duration of the test.

Duration of Test: 8 h.

Acceptance: The protection is satisfactory if, on inspection, talcum powder has not accumulated in a quantity or location such that has with any other kind of dust; it could interfere with the correct operation of the equipment or impair safety.

Test means and main test conditions for the tests for protection against water

| Test Means | Water flow | Duration | Test conditions |
|---|---|--|--|
| Oscillating tube, as per test std., Spray ± 180 deg from vertical distance, max. 200 mm vertical or Spray nozzle, as per std. Spray ± 180 deg from vertical | 0,07 l/min \pm 5 % multiplied by number of holes 10 l/min \pm 5 % | 10 min 1 min/m ² at least 5 min | As per test standard As per test standard |

For EVSE –AC IP for Indoor applications: IP 23

Test means and main test conditions for the tests for protection against dust.

Test means: The object probe (rigid sphere without handle or guard with 12.5 mm diameter) is pushed against any openings of the enclosure with the force $30 \text{ N} \pm 10 \%$.

Duration of Test: 8 h.

Acceptance: The protection is satisfactory if, the protection is satisfactory if the full diameter of the object probe does not pass through any opening.

Test means and main test conditions for the tests for protection against water

| Test Means | Water flow | Duration | Test conditions |
|---|---|------------------------------------|----------------------|
| Oscillating tube, as per test std., Spray ± 60 deg from vertical distance, max. 200 mm vertical | $0.07 \text{ l/min} \pm 5 \%$ multiplied by number of holes | 10 min | As per test standard |
| or | | | |
| Spray nozzle, as per std. Spray ± 60 deg from vertical | $10 \text{ l/min} \pm 5 \%$ | 1 min/m^2 at least 5 min | As per test standard |

11.11.3 **Electromagnetic environmental tests**

11.11.3.1 **Immunity to EM disturbances**

General

The electric vehicle charging station shall not become dangerous or unsafe as a result of the application of the tests defined in this standard.

A functional description and a definition of performance criteria during, or as a consequence of, the EMC testing shall be provided by the manufacturer and noted in the test report based on the following criteria.

Performance criterion A: The apparatus shall continue to operate as intended. No degradation of performance or loss of function is allowed below a performance level specified by the manufacturer when the apparatus is used as intended. In some cases, the performance level may be replaced by a permissible loss of performance. If the minimum performance level or the permissible performance loss is not specified by the manufacturer then either of these may be derived from the product description and documentation (including leaflets and advertising) and what the user may reasonably expect from the apparatus if used as intended.

Performance criterion B: The apparatus shall continue to operate as intended after the test. No degradation of performance or loss of function is allowed below a performance level specified by the manufacturer when the apparatus is used as intended. In some cases, the performance level may be replaced by a permissible loss of performance. During the test, however, degradation of performance is allowed. No change of actual operating state or stored data is allowed. If the minimum performance level or the permissible performance loss is not specified by the manufacturer then either of these may be derived from the product description and documentation (including leaflets and advertising) and what the user may reasonably expect from the apparatus if used as intended.

Performance criterion C: Temporary loss of function is allowed, provided the loss of function can be restored by operation of the controls.

In any case, safety functions and metering shall be maintained (level A).

11.11.3.2 Immunity to electrostatic discharges

The EVSE – AC shall withstand electrostatic discharges.

Minimal requirement (IEC 61000-4-2) / IS 14700 (Part 4/See 2): 8 kV (in air discharge) or 4 kV (contact discharge).

Performance criterion: B.

Compliance is checked according to IEC 61000-4-2/ IS 14700 (Part 4/See 2). In the standard, the contact discharge method is mandatory. Tests shall be carried out with the EVSE - AC connected to a resistive load at its rated output power.

Immunity to low-frequency conducted disturbances

Tests shall be carried out with the EVSE - AC connected to a resistive load at its rated output power.

a) Supply voltage harmonics

The EVSE – AC, powered by the a.c. supply network (mains), shall withstand the voltage harmonics of the main supply, in the frequency range 50 Hz - 2 kHz, generally caused by other non-linear loads connected to the a.c. supply network.

Minimum requirement: compatibility levels of IEC 61000-2-2 multiplied by a factor of 1, 7. Performance criteria: A for charging functions.

Compliance is checked by simulating the above conditions (IEC 61000-4-1/ IS 14700 (Part 4/sec 1)).

b) Supply voltage dips and interruptions

The EVSE - AC, powered by the a.c. supply network (mains), shall withstand the voltage dips and interruptions of the a.c. supply, generally caused by faults on the a.c. supply network.

Minimum requirement: voltage reduction of 30 % of nominal voltage for 10 ms. Performance criterion: B for charging functions.

Minimum requirement: voltage reduction of 50% for 100 ms.

Performance criterion: B for charging functions.

Minimum requirement: voltage reduction >95% for 5 s.

Performance criterion: B for charging functions.

Compliance is checked by simulating the above conditions (see IEC 61000-4-11/ IS 14700 (Part 4/ sec 11)).

c) Immunity to voltage unbalance

The EVSE - AC, powered by a three-phase a.c. supply (mains), shall withstand voltage unbalance of the a.c. supply.

Minimum requirement: under consideration.

Performance criteria: under consideration.

d) DC component

The EVSE - AC, powered by the a.c. supply network (mains), shall withstand the d.c. components, generally caused by asymmetrical loads.

Minimal requirement: under consideration.

Performance criteria: under consideration.

Immunity to high-frequency conducted disturbances

Tests shall be carried out with the EVSE – AC connected to a resistive load at its rated output power.

a) Fast transient bursts

The EVSE - AC, powered by the a.c. supply network (mains), shall withstand common-mode conducted disturbances to levels given in IEC 61000-4-4/ IS 14700 (Part 4/Set 4), generally caused by the switching of small inductive loads, relay contacts bouncing, or switching of high-voltage switchgear.

Minimal requirement (IEC 61000-4-4/ IS 14700 (Part 4/Set 4)): 2 kV, for a time greater than 1 min and a repetition rate of the impulses of 5 kHz.

Performance criterion: B for charging functions.

Compliance is checked by tests according to IEC 61000-4-4/ IS 14700 (Part 4/Set 4).

The tests shall be made on all power cables and on I/O signal and control cables, if any, normally connected to EVSE - AC during the charge. For I/O signal and control cables the voltage level is divided by two.

b) Voltage surges

The EVSE - AC, powered by the a.c. supply network (mains), shall withstand the voltage surges, generally caused by switching phenomena in the power a.c. supply network, faults or lightning strokes (indirect strokes).

Minimal requirement: 1.2/50 uS surges, 2 kV in common mode, 1 kV in differential mode. Performance criteria: C for charging functions.

Compliance is checked by tests according to IEC 61000-4-5.

The tests shall be made on all power cables. Tests shall be carried out with the EVSE - AC connected to a resistive load at rated output power.

Immunity to radiated electromagnetic disturbances

The EVSE - AC shall withstand radiated electromagnetic disturbances.

Minimal requirement (IEC 61000-4-3): 3 V/m in the frequency range 80 MHz to 1000 MHz.

Performance criterion: A.

Minimal requirement (IEC 61000-4-3): 10 V/m in the frequency range 80 MHz to 1000 MHz.

Performance criterion: B.

Compliance is checked by tests according to IEC 61000-4-3.

Tests shall be carried out with the EVSE - AC connected to a resistive load at rated output power.

11.11.3.3 Emitted EM disturbances**Low-frequency conducted disturbances**

Input current distortion of the EVSE – AC shall not be excessive.

The harmonic limits for the input current of the EVSE - AC, with no load connected, shall be in accordance with IEC 61000-3-2.

Compliance is checked according to IEC 61000-3-2.

High frequency conducted disturbances**a) AC input terminal**

Conducted disturbances emitted at the input of the EVSE - AC, with a resistive load at its rated output power, shall be less than the amplitude of the level defined in Table 1.

Table 1 : Limit levels of conducted Interference AC supply Network

| Frequency Range (MHz) | Limits dB (uV) | |
|--------------------------|----------------|----------|
| | Quasi –Peak | Average |
| 0,15 to 0,50 | 66 to 56 | 56 to 46 |
| 0,50 to 5 | 56 | 46 |
| 5 to 30 | 60 | 50 |

NOTE 1 - The lower limit shall apply at the transition frequencies.

NOTE 2 - The limit decreases linearly with the logarithm of the frequency in the range 0,15 MHz to 0,50 MHz

Compliance is checked according to CISPR 22.

b) Signal I/O and control terminals

Conducted disturbances emitted at signal I/O and control terminals, if any, shall be less than the amplitude of the level defined in Table 2, using a quasi-peak detector.

Table 2 : Conducted Interference signal I/O and control

| Frequency Range (MHz) | Limits dB (uV) | |
|--------------------------|----------------|----------|
| | Quasi –Peak | Average |
| 0,15 to 0,50 | 40 to 30 | 30 to 20 |
| 0,5 to 30 | 30 | 20 |

NOTE 1 - The limits decrease linearly with the logarithm of the frequency in the range 0,15 MHz to 0,5 MHz.

Compliance is checked according to CISPR 22.

Radiated electromagnetic disturbances

a) Magnetic field (150 kHz- 30 MHz)

Under consideration.

b) Electrical field (30 MHz- 1000 MHz)

Radiated disturbances by the EVSE-AC at 10 m, operating with a resistive load at its rated output power, shall not exceed the limits given in Table 3, using a quasi-peak detector.

Table 3 : Limit Levels of radiated emissions – enclosure at a measuring distance of 10m

| Frequency range (MHz) | Radiated Interference (dBuV/m) |
|-----------------------|--------------------------------|
| 30 to 230 | 30 |
| 230 to 1000 | 37 |

NOTE 1 - The lower limit shall apply at the transition frequency.

NOTE 2 - Additional provisions may be required for cases where interference occurs.

Compliance is checked according to CISPR 22.

11.12 **Latching of the retaining device**

An interlock may rely on the retaining device to avoid disconnection under load if this function is not provided by the connector.

11.13 **Service**

The socket-outlet should be designed so that a certified technician could remove, service and replace it if is necessary.

11.14 **Marking and instructions**

11.14.1 **Connection instructions**

Instructions for the connection of the electric vehicle to the EVSE - AC shall be provided with the vehicle, with the user's manual and on the EVSE – AC.

11.14.2 **Legibility**

The markings required by this standard shall be legible with corrected vision, durable and visible during use.

Compliance is checked by inspection and by rubbing the marking by hand for 15 s with a piece of cloth soaked with water and again for 15 s with a piece of cloth soaked with petroleum spirit.

After all the tests of this standard, the marking shall be easily legible; it shall not be easily possible to remove marking plates and they shall show no curling.

11.14.3 **Marking of EVSE – AC**

The station shall bear the following markings in a clear manner:

- Name or initials of manufacturer;
- Equipment reference;
- Serial number;
- Date of manufacture; rated voltage in V; rated frequency in Hz; rated current in A; number of phases;
- IP degrees;
- "Indoor Use Only", or the equivalent, if intended for indoor use only;
- Class of EV depending on Load Capacity (Annex E)

For a Class II station, the symbol shall clearly appear in the markings;

Some minimal additional information can possibly appear on the station itself (phone number, address of contractor).

Compliance is checked by inspection and tests.

11.15 **Telecommunication network**

Tests on any telecommunication network or telecommunication port on the EVSE, if present, shall comply with IEC 60950-1.

ANNEX A:

Pilot function through a control pilot circuit using PWM modulation and a control pilot wire (Normative)

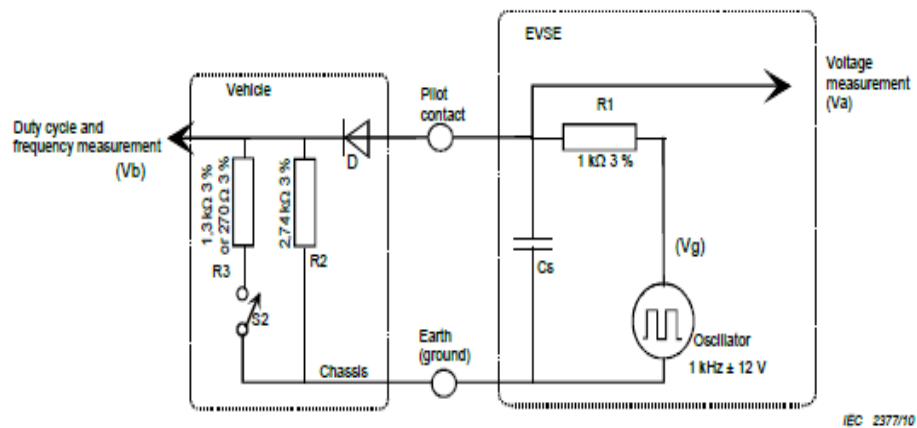
A.1 General

This annex concerns all charging systems that ensure the pilot function with a pilot wire circuit with PWM modulation in order to define the available current level in AC Slow and AC Fast charging. This annex describes the functions and sequencing of events for this circuit based on the recommended typical implementation circuit parameters.

NOTE: This annex is not applicable to vehicles using pilot functions that are not based on a PWM signal and a pilot wire.

A.2 Control pilot circuit

Figure A.1 and A.2 show the basic principle of operation of the control pilot circuit. Parameters of the circuits are defined in Table A.1, Table A.2, Table A.3, Table A.5, Table A.6, and Table A.7



NOTE: Stray capacities (C_v and C_c) between pilot and earth are not shown on figure (see Tables A.1 and A.2).

Figure A.1 - Typical control pilot circuit

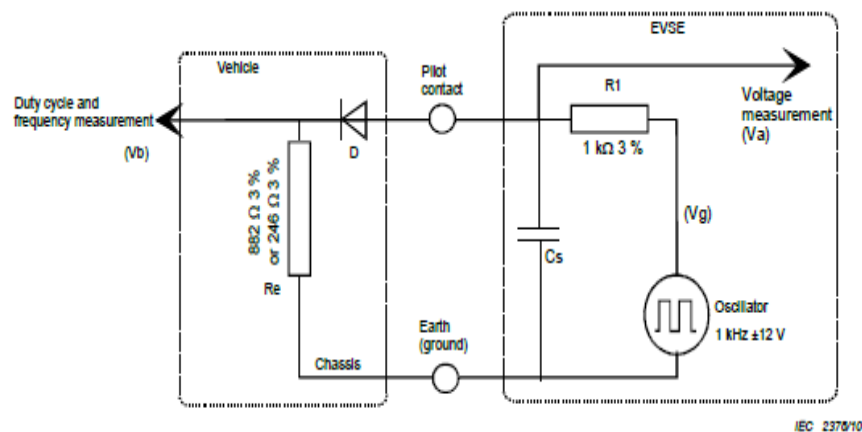


Figure A.2 – Simplified control pilot circuit

The simplified circuit shall not be used for vehicles drawing more than 15 A single phase. It shall not be used with 3-phase supply.

NOTE: This circuit gives an equivalent result to the circuit shown in Figure A.1 when the switch S2 is closed. The simplified control pilot circuit cannot create vehicle states A and B as defined in Table A.3.

Table A.1: EVSE Control Pilot Circuit Parameters (see Figures A.1 and A.2)

| Parameter ^a | Symbol | Value | Units |
|--|--------------------------------|---------------------------|-------|
| Generator open circuit positive voltage ^c | V _{och} | 12.00 (+/- 0.6) | V |
| Generator open circuit negative voltage ^c | V _{ocl} | -12.00 (+/- 0.6) | V |
| Frequency | F _o | 1000 (+/- 0.5 %) | Hz |
| Pulse Width ^{b,c} | P _{wo} | Per Table A.4 (+/- 25 μs) | μs |
| Maximum Rise Time (10% to 90%) ^c | T _{rg} | 2 | μs |
| Maximum Fall Time (90% to 10%) ^c | T _{fg} | 2 | μs |
| Minimum Settling time to 95% steady state ^c | T _{sg} | 3 | μs |
| Equivalent Source Resistance ^c | R1 | 1000 +/- 3% | Ω |
| Recommended EMI suppression | Cs | 300 | pF |
| Maximum Total Cable ^d Capacity + Cs | C _s +C _c | 3100 | pF |

a. Tolerances to be maintained over the full useful life and under environmental conditions as specified by the manufacturer.
b. Measured at 0 V crossing of the +/- 12 V Signal.
c. Measured at point Vg as indicated on Figure A.1.
d. Typical vehicle cord capacities (Cc) should be minimized and less than 2000 pF

Table A.2: Vehicle control pilot circuit values and parameters (see Figures A.1, A.2)

| Parameter | Symbol | Value | Units |
|--|--------|----------------|-------|
| Permanent resistor value | R2 | 2.74k (+/- 3%) | Ω |
| Switched resistor value for vehicles not requiring Ventilation | R3 | 1.3k (+/- 3%) | Ω |
| Switched resistor value for vehicles requiring Ventilation | R3 | 270 (+/- 3%) | Ω |
| Equivalent total resistor value no ventilation (Figure A.2) | Re | 882 (+/- 3 %) | Ω |
| Equivalent total resistor ventilation required (Figure A.2) | Re | 246 (+/- 3 %) | Ω |
| Diode Voltage Drop (2.75 – 10 mA, -40 °C to + 85 °C) | Vd | 0.7 (+/- 0.15) | V |
| Maximum total equivalent input capacity | Cv | 2400 | pF |

Tolerances are to be maintained over full useful life and under design environmental conditions.

Table A.3: Pilot Functions

| Vehicle State | Vehicle Connected | S2 | Charging Possible | Va ^a | Vb |
|---------------|-------------------|--------|-------------------|-------------------|--|
| A | No | Open | No | 12 V ^d | Vb = 0 |
| B | Yes | Open | No | 9 V ^b | R2 detected |
| C | Yes | Closed | Vehicle Ready | 6 V ^c | R3 = 1.3 kΩ +/- 3% Charging area ventilation not required |
| D | | | | 3 V ^c | R3 = 270 Ω +/- 3% Charging area ventilation required |
| E | Yes | Open | No | 0 V | Vb=0: EVSE, utility problem or utility power not available, pilot short to earth |
| F | Yes | Open | No | -12 V | EVSE not available |

- a. All Voltages are measured after stabilization period, tolerance +/- 1V
- b. The EVSE generator may apply a steady state DC Voltage or a +/-12V square wave during this period. Duty cycle indicates the available current as in Table A.5.
- c. The Voltage measured is a function of the value of R3 in Figure A.1. (Indicated as Re in Table A.2)
- d. 12V Static voltage

Typical Start-up and Shut-down sequence:

The figure A.3 shows the sequence of a typical charging cycle under normal operating conditions. The sequences are detailed in Table A.4.

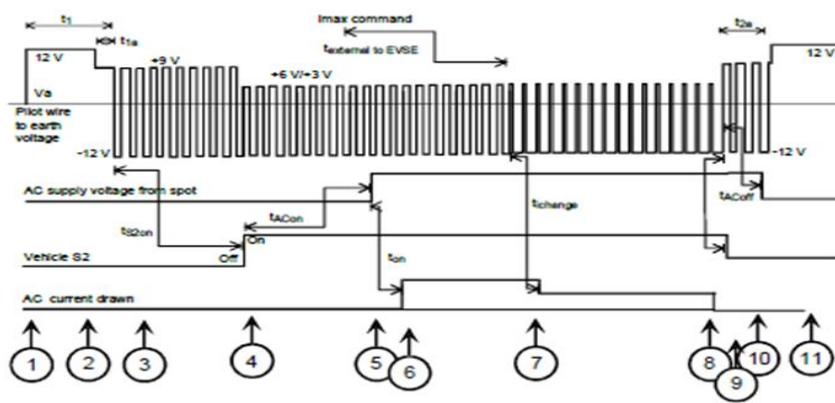


Figure A.3 – Typical charging cycle under normal operating conditions

Table A.4: Description of Connecting sequences as shown in Figure A.3

| Sr. No. | State | Conditions |
|----------------|--------------|---|
| 1 | A | Vehicle unconnected – the full generator voltage is measured by the EVSE at Va (See Figure A.1). The generator signal Vg is a +12V DC voltage |
| 2 | B | The cable assembly is connected to the vehicle and to the EVSE. This condition is detected by the 9 V signal measured at Va. The voltage from signal generator (Vg) may be either a steady state + 12 V DC or a +/- 12 V, 1 kHz in conformity with Table A.1 if the EVSE is immediately available for the supply of energy. |
| 3 | B | The EVSE is now able to supply energy and indicated the available current to the vehicle by the duty cycle in conformity with Table A.5. The presence of the Diode D (See Figure A.1) is detected by the -12 V and gives added guarantee that the 9V signal is a reliable indication of a vehicle connected. |
| 4 | B -> C,D | S2 is closed by vehicle as a function of requirements to indicate that the vehicle can receive energy. There are no timing requirements for the closing of On. |
| 5 | C,D | EVSE closes circuit. The timing of switch closure may be subject to other requirements (Payment, Data Exchange). If state D is detected, the switch will close only if ventilation requirements are met. |
| 6 | C,D | Current drawn from the vehicle. The timing and current profile are determined by the vehicle. Current may not exceed that indicated by the Duty Cycle (Table A.5). |
| 7 | C,D | External demand for power reduction. Such a demand may originate from the grid or by manual setting on EVSE. The vehicle adjusts the current demand to that indicated by the duty cycle. |
| 8 | C,D | End of charge, decided by the vehicle. |
| 9 | C,D -> B | Vehicle asks for disconnect. This may be the result of Proximity contact being opened. |
| 10 | B | EVSE detects state B (created by opening of S2 on vehicle) and opens the contactor. |
| 11 | A | Complete removal of cable assembly from vehicle or EVSE is detected by the 12V Signal. |

NOTE: The EVSE should allow removal of the plug if the end of the Charging session is ended by entering State A.

Table A.5: Pilot Duty Cycle Provided by EVSE

| Available Line Current | Nominal Duty Cycle Provided by EVSE (Tolerance +/- 1 percent point) |
|---|--|
| Digital Communication will be used to control an Off-board DC Charger or communicate available line current for an On-board charger | 5% Duty Cycle |
| Current from 6 A to 51 A | $(\% \text{ Duty cycle}) = \text{current}[\text{A}] / 0.6$ $10\% \leq \text{Duty Cycle} \leq 85\%$ |
| Current from 51 A to 80 A | $(\% \text{ Duty cycle}) = (\text{current} [\text{A}] / 2.5) + 64$ $85\% < \text{Duty Cycle} \leq 96\%$ |

Table A.6: Maximum Current to be drawn by Vehicle

| Nominal Duty Cycle Interpretation by Vehicle | Maximum current to be drawn by vehicle |
|--|---|
| Duty Cycle < 3% | Charging not allowed |
| $3\% \leq \text{Duty Cycle} \leq 7\%$ | Indicates that digital communication will be used to control an off-board DC charger or communicate available line current for an on-board charger. Digital communication may also be used with other duty cycles. Charging is not allowed with digital communication. 5% Duty cycle shall be used if the pilot function wire is used for digital communication |
| $7\% \leq \text{Duty Cycle} \leq 8\%$ | Charging not allowed |
| $8\% \leq \text{Duty Cycle} \leq 10\%$ | 6 A |
| $10\% \leq \text{Duty Cycle} \leq 85\%$ | Available current = (% duty cycle) x 0.6 A |
| $85\% \leq \text{Duty Cycle} \leq 96\%$ | Available current = (% duty cycle – 64) x 2.5 A |
| $96\% \leq \text{Duty Cycle} \leq 97\%$ | 80 A |
| Duty Cycle > 97% | Charging not allowed |
| If the PWM signal is between 8% and 97%, the maximum current may not exceed the values indicated by the PWM even if the digital signal indicates a higher current. | |

Table A.7: EVSE Timing (see Figure A.3)

| | | | |
|--|----------------|--|--|
| t_1 and t_{1a} | No maximum | Turn on of 1 kHz oscillator | The frequency and voltage shall always conform to the values indicated in Table A.1 |
| t_{ACon} | 3 s | Beginning of supply of AC power after detection of State C or State D (vehicle request for energy). This time can be extended if there is digital communication established within this time. | If conditions cannot be met EVSE should send one of the following: Steady state voltage 5% PWM, state E or F |
| $t_{external}$ | 10 s | Modification of pulse-width in response to an external command to EVSE. | The external command may be a manual setting or command from grid management systems. |
| t_{ACoff1} | 100 ms maximum | Delay until contactor opens and terminates AC energy transfer in response to S2 opened | S2 will cause pilot voltage change which, when detected by EVSE causes opening of contractors |
| T_{2a} | No maximum | The state B is maintained while the vehicle is connected provided the EVSE is capable of supplying further energy. | The duty cycle shall indicate the current available as in Table A.5. |
| $t_{ventilation}$ (not shown in Figure A.3) | 3 s maximum | Delay for ventilation command turn on after transition from state C (6V) to state D(3V) | |
| Other conditions for termination of energy supply | | | |
| | 3 s maximum | Delay for opening of contacts to terminate energy supply if abnormal conditions are encountered. | This typically includes out of spec voltages of pilot, ventilation, non-respect of current drawn (if measured by EVSE). |
| | 3 s maximum | Delay for turning off the square wave oscillator after transition from State B, C or D to state A. | |
| | 100 ms maximum | Delay for opening contact if local proximity switch is opened. | This applies to connectors using the proximity contact. |
| | 2 s maximum | Delay for applying a static 12V signal after transition from state B, C or D, to state A. | |

| EV timing (figure A.3) | | | |
|-------------------------------|------------|--|---|
| T_{S2} | No maximum | S2 turn – request for AC supply | Determined by EV requirements |
| t_{on} | No maximum | Beginning of charging | The charging profile and timing are controlled by the vehicle. Ramp up of current should only be possible when voltage is detected. |
| t_{ACoff2} | 3s maximum | Stop charger current draw, set S2 open if Pilot signal out of tolerance, state E or state F detected | Only applies to systems using complete pilot circuit described in Figure A.1 |
| t_{change} | 5s maximum | Change of current following change in PWM duty cycle | |
| | 100 ms | Delay for stopping charging current drawn by vehicle if proximity contact opened | Not shown on diagram |

ANNEX B:**Example of a circuit diagram for a basic vehicle coupler
(Informative)****B.1 General**

This annex describes circuit diagrams for AC charging methods using the basic interface (see Figures B.1 and B.2).

B.2 Circuits diagrams for AC Charging modes, using a basic single phase vehicle coupler

Clause B.2 of this annex shows the application of a single phase basic interface fitted with a switch on the proximity circuits.

Clause B.3 of this annex shows the application of a three phase basic interface that is not fitted with a switch on the proximity circuit, used for single and three-phase supply.

Components and functions in the circuit diagrams shown in Figures B.1 and B.2 are as follows.

The pilot function controller is located on the mains side.

This circuit realizes the basic functions described in Annex A. The circuit is normally supplied from a low voltage source that is isolated from the mains by a transformer and contains a ± 12 V, 1000 Hz pulse width modulated oscillator that indicates the power available from the socket.

Pilot function circuit:

AC Fast charging mode diagram is drawn with a hard wired pilot functions as described in Annex A. The basic functions described in Annex A are represented by R1, R2, R3, D and S2 (see Figure A.1).

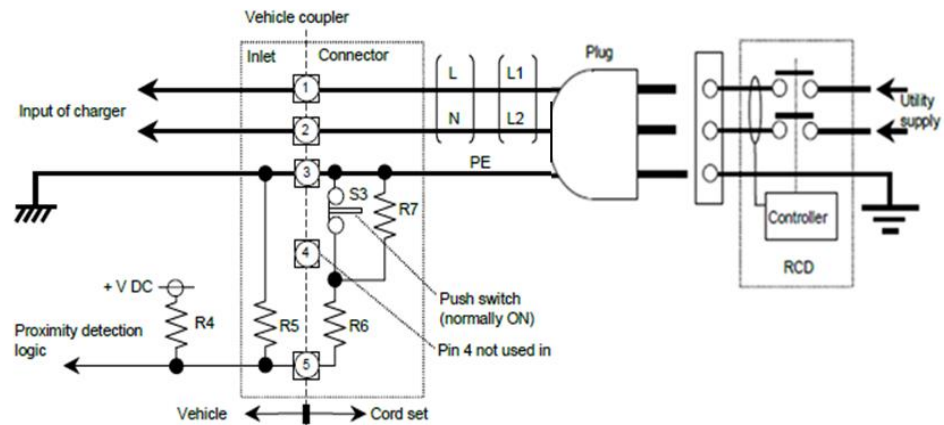
The values indicated in Annex A should be used. (See Table A.2).

| | Name of component | Functions |
|-------------------|--|--|
| 1, 2 | Phase and neutral contacts | Vehicle coupler power contacts |
| 3 | Earth protection contact | |
| 4 | Pilot function contact | |
| 5 | Proximity detection contact | Indicates the presence of the connector to vehicle. Used to signal correct insertion of the vehicle connector into the vehicle inlet. Can be used to avoid Un-intentional live disconnect (see Figure B.1 and Note). |
| R1,R2,R3,D,S1,S2, | Resistances, diodes and control switch | Components necessary for hard wired control pilot function |

| | | |
|----------------|------------------------------------|---|
| R4,R5,R6,R7,S3 | Resistances and push button switch | Components necessary for proximity detection function |
|----------------|------------------------------------|---|

NOTE: The auxiliary coupler contact can be used for un-intentional live disconnect avoidance using switch on vehicle connector. For this function, the push button is linked to a mechanical locking device. The depressing S3 un-locks the coupler and opens the circuit. The opening of S3 stops charging operation and contributes to prevention of un-intentional live disconnect.

This function may also be achieved using proximity switches or contacts on the vehicle inlet cover or on the locking device.



NOTE 1: There is no pilot function in AC slow charging mode and pin 4 is not compulsory.

NOTE 2: In this drawing switch S3 can be used for prevention of un-intentional live disconnect.

Figure B.1

AC Slow Charging Mode with output option 1 using basic single phase vehicle coupler

B.3 Component values for all diagrams in Figures B.1 and B.2

Component values for all diagrams in Figures B.1 to B.2 are specified in Table B.2.

| Table B.2 –Component values for all drawings | | |
|--|----------------------------------|-------------|
| | Value | Tolerance |
| R1, R2, R3 | As defined in Tables A.1 and A.2 | |
| R4 | 330 Ω | $\pm 10 \%$ |
| R5 | 2700 Ω | $\pm 10 \%$ |
| R6 | 150 Ω | $\pm 10 \%$ |
| R7 | 330 Ω | $\pm 10 \%$ |
| +V DC | Low voltage supply ^a | |
| ^a A +5 V regulated supply is recommended. | | |

B.4 Circuits diagrams for AC Fast Charging, using a basic three-phase accessory without proximity switch

Figure B.2 shows a three phase interface accessory that is used three phase supply. The current coding function described in B.4 is indicated. Values of the pull-up resistances and the Rc are indicated in Table B.3.

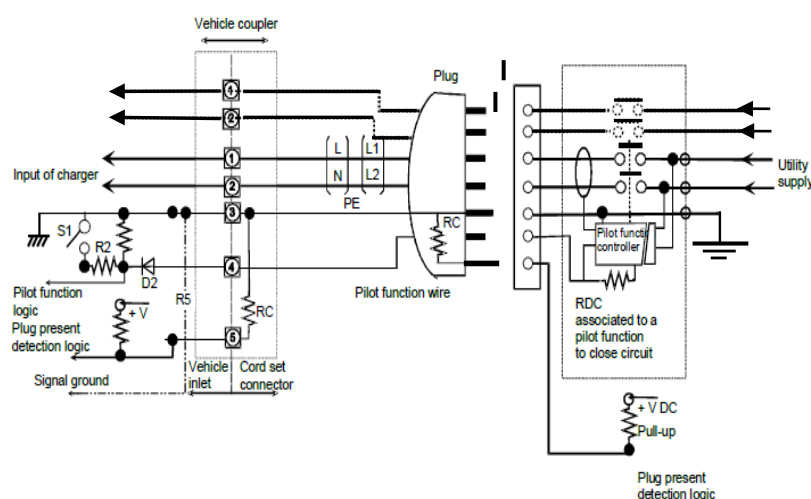


Figure B.2:

AC Fast charging with output option 1 using the basic three phase vehicle coupler without proximity push button switch S3

NOTE: The schemes indicated in Figures 1, 2 and 3 can also be realized with this connector provided the switch S3 is not required.

B.5 System for simultaneous proximity detection and current coding for vehicle connectors and plugs

Vehicle connectors and plugs using the proximity contact for simultaneous proximity detection and current capability coding of the cable assembly set shall have a resistor electrically placed between proximity contact and earthing contact (see Figure B.5) with a value as indicated in Table B.3.

The resistor shall be coded to the maximum current capability of the cable

assembly.

The EVSE shall interrupt the current supply if the current capability of the cable is exceeded as defined by the value of R_c . The resistor is also used for proximity detection.

| Table B.3 | |
|---|--|
| Resistor coding for vehicle connectors and plugs | |
| Current capability of the cable assembly | Equivalent resistance of R_c Tolerance $\pm 3\%$ ^c |
| 13 A | 1.5 k Ω , 0.5 W ^{a, b} |
| 20 A | 680 Ω , 0.5 W ^{a, b} |
| 32 A | 220 Ω , 0.5 W ^{a, b} |
| 63 A (3 phase) / 70 A (1 phase) | 100 Ω , 0.5 W ^{a, b} |

^a The power dissipation of the resistor caused by the detection circuit shall not exceed the value given above.

The value of the pull-up resistor shall be chosen accordingly.

^b Resistors used should preferably fail open circuit failure mode. Metal film resistors commonly show acceptable properties for this application.

^c Tolerances to be maintained over the full useful life and under environmental conditions as specified by the manufacturer.

Coding resistors, as indicated in Table B.3 shall be used in vehicle connectors and plugs, Type 2.

NOTE: Type 2 vehicle connectors and plugs are being included in IEC 62196-2 (under development).

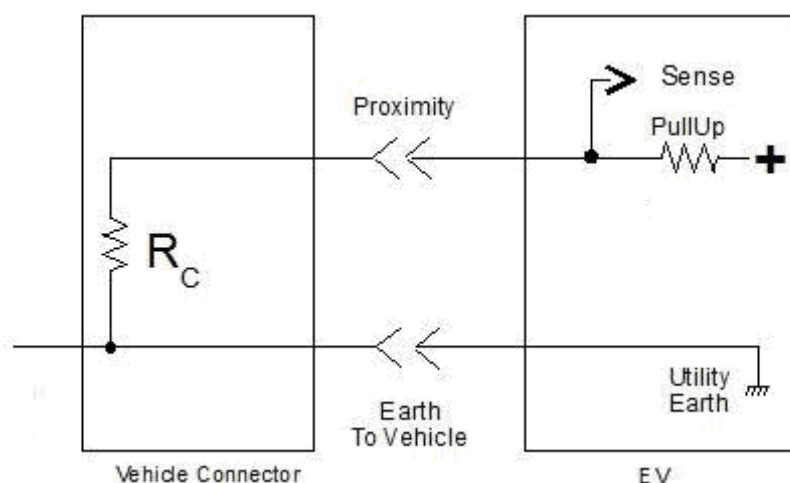


Figure B.4

Diagram for current capability coding of the cable assembly

The same circuit diagram is used for the plug and EVSE outlet.

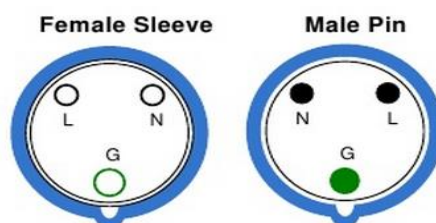
ANNEX C

Connectors for AC Slow Charging and AC Fast Charging

C.1 AC Slow:

The connector (female) to be used on the EVSE Side for AC Slow Charging is IEC 60309. The connector will be used at the ratings mentioned under EVSE – AC Slow. IEC 60309 Blue Connectors are to be used for this application.

The connector on the EVSE side and the mating connector are as below:

IEC 60309 Female Connector**IEC 60309 Male Connector**

| Pins | Function |
|------|------------------|
| 1 | L |
| 2 | N |
| 3 | Protective Earth |

For details, refer **IS 60309(Part 1): 2002/ IEC 60309-1:1999**, Plugs, socket-outlets and couplers for industrial purposes – Part 2: Dimensional interchangeability requirements for pin and contact-tube accessories.

C.2 AC Fast:

The connector (female) to be used on the EVSE Side for AC Fast Charging is IEC 62196 – Type 2. The connector will be used at the ratings mentioned under EVSE – AC Fast.

IEC 62196-Type 2 Female Connector



IEC 62196-Type 2 Male Connector



| Pins | Function |
|------|------------------|
| 1 | L1 |
| 2 | L2 |
| 3 | L3 |
| 4 | N |
| 5 | Control Pilot |
| 6 | Protective Earth |
| 7 | Proximity |

For details, refer **IEC 62196-1:2003**, Plugs, socket-outlets, vehicle couplers and vehicle inlets – Conductive charging of electric vehicles – Part 1: Charging of electric vehicles up to 250 A a.c. and 400 A D.C.

ANNEX D

Cable Assembly for AC Slow Charging and AC Fast Charging

The connection between the EVSE - AC and the vehicle should be established via appropriate charging cables. Refer to the diagrams in 6.2 for the connection options.

The following guidelines should be referred for using different type of cable assemblies for charging options in AC Slow and AC Fast charging.

| Cable Name | Description | EVSE Outlet |
|-------------------|---|--------------------|
| A | EVSE to Power Converter and Power Converter to EV | AC Slow |
| B | EVSE to EV | AC Slow |
| C | Attached to EVSE | AC Slow |
| D | EVSE to EV | AC Fast |
| E | Attached to EVSE | AC Fast |
| F | Extension Cable for D to connect to EV | AC Fast |

NOTE: Refer 6.2.1 and 6.2.2

EVSE - AC Slow

Cable A: The cable should have an industrial plug IEC 60309 (15 A, single-phase) on the EVSE side and a suitable charging connector on the vehicle side with a power converter box in-inline. The cable may be integrated with the Power converter or may be connected using connectors.



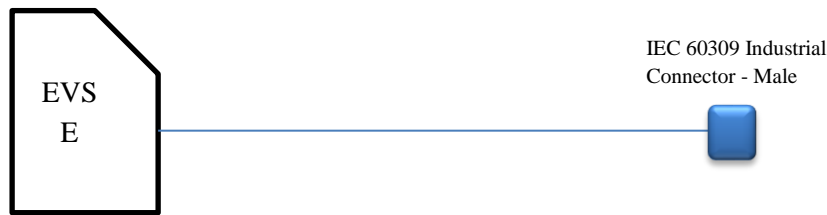
Example for Cable A

Cable B: The cables should have an industrial plug IEC 60309 (15 A, single-phase) on the EVSE side and a suitable charging connector on the vehicle side.



Example for Cable B

Cable C: The cable be hardwired with EVSE – **AC Slow** and should have and should have an industrial plug IEC 60309 (15 A, single-phase) at the end of the Cable.



Example for Cable C

Cable Assembly Specification for Cable A,B and C:

For < 1 kw

- All the cables and pins should have no power on them until the connector is safely plugged into a vehicle/ power converter.
- Cables will be assembled in such a way, that they cannot be re-connected again, so that no opening and manipulation is possible.
- Maximum length: Total 7.5m
- Colour of the cable sheath: Orange/ Black
- Nominal Voltage: Single phase : Refer IS 12360
- Operating charging current: up to 15 A (max)
- Cable construction: Refer IEC 60245-6/ IS 9857 (*Welding cables - Specifications*)
- Protective type: IP 44
- Operating temperature: 0 to 55 deg C

For > 1 kW

- All the cables and pins should have no power on them until the connector is safely plugged into a vehicle/ power converter.
- Cables will be assembled in such a way, that they cannot be re-connected again, so that no opening and manipulation is possible.
- Maximum length: Total **7.5** m
- Colour of the cable sheath: Orange/ Black
- Nominal Voltage: Single phase: Refer IS 12360
- Operating charging current: up to 15A (max)
- Cable construction: As per As per IEC 60245-6 /IS 9857 (*Welding cables - Specifications*)
- Protective type: IP 44
- Operating temperature: 0 to 55 deg C
- Vehicle drive over requirements and compliance: As per IEC 62196-part 1 (Clause 33)

Note: Refer IEC 60245-6 /IS 9857 for cable mechanical properties and testing

EVSE - AC Fast

Cable D: The cable should have an IEC 62196 type 2 plug (63A, three-phase 415V) on the EVSE side and a suitable charging connector on the vehicle side.



Example for Cable D

Cable E: The cable be hardwired with EVSE – AC Fast and should have IEC 62196 type 2 socket (63A, three-phase 415V) on the other side.



Example for Cable E

Cable F: The cable should have an IEC 62196 type 2 plug (63A, three-phase 415V) on one side and a suitable charging connector on the vehicle side.



Example for Cable F

Cable Assembly Specification for Cable C, D and E:

- All the cables and pins should have no power on them until the connector is safely plugged into a vehicle.
- Cables will be assembled in such a way, that they cannot be re-connected again, so that no opening and manipulation is possible.
- Maximum length: C,D –**7.5 m** E – 1 m
- Colour of the cable **sheath:** Orange/ Black

For Power Cables,

- Rated Voltage: 415 V (Three phase)
- Operating charging current: up to 63A (max)
- **Cable construction:** As per IEC 60245-6/ IS 9857 (Welding cables - Specifications)

- Automatic charging current reduction at excessive heat
- Nominal residual current: 30 mA
- Protective type: IP 44
- Operating temperature: 0 to 55° C

For Communication cables,

For the communication demands, typically two signal contacts and a hybrid-cable with an additional 1 x 0.5 mm² conductor are required.

- Rated Voltage: 30 V (Three phase)
- Operating charging current: 2 A (max)
- Cable size: 0.5 mm² multicore copper/ aluminium equivalent
- Vehicle drive over requirements and compliance: As per IEC 62196-part 1 (Clause 33)

Note: Refer IS 9857:1990: 1988/ IEC 60245-6 for cable mechanical properties and testing.

ANNEX E

EVSE Categories Based On Load Capacity

EVSE may be classified according to their maximum operating loads. Before installation, it should be ensured that the EVSE rating is lower than the Sanctioned load at the location where it is intended for use.

EVSE should be suitably labelled according to the Class and Maximum permissible loads.

| EVSE Class | Maximum Load |
|-------------------|---------------------|
| AC-Slow A | 1 kW (1 Phase) |
| AC-Slow B | 2.2 kW (1 Phase) |
| AC-Slow C | 3.3 kW (1 Phase) |
| AC-Fast A | 10 kW (3 Phase) |
| AC-Fast B* | 12 kW (3 Phase) |
| AC-Fast C* | 23 kW (3 Phase) |
| AC-Fast D* | 45 kW (3 Phase) |

* Need permission for installation from the electricity board

ANNEX F

Power Converters (AC to DC)

A power converter is an AC - DC Converter to fulfil DC power requirements for charging of electric vehicles. Power converter is required for the EVs which don't have an on-board charger. The power converter will be connected to EVSE - AC Slow in AC Slow charging mode as shown in 6.2.1. For the necessary cable connections refer to Annex D.

The power converter should be rugged, simple to use, compact in size and water proof. It should meet all necessary functional and safety requirements for charging of all supported types of electric vehicles.

Recommended Features:

- Input nominal voltage: single phase AC : Refer IS 12360
- Input Frequency: 50 Hz
- Maximum Rated Power : 1.1 kW
- Output Voltage: DC Voltage range as suitable for the EV
- Power ON indication
- Fault indication
- Mandatory safety features:
 - Ground fault detection
 - Output overload protection
 - Output short circuit protection
 - Output over voltage Protection
 - Connector presence and locking
 - Battery reverse protection
- Power Factor ≥ 0.9

Environmental:

- Operating temperature: 0 to 55°C
- IP Rating: Same as EVSE - AC Slow
- EMI compliance: Same as EVSE - AC Slow
- Safety compliance: Same as EVSE - AC Slow

ANNEX G
Periodic Compliance of EVSE

In addition to the conformity testing of the EVSE after manufacturing, the equipment should be tested yearly during its operation to ensure that there is no lapse of Safety or deterioration in functionality of the EVSE.

The EVSE must be assessed periodically for the following:

Generic Functional Verification: like VIN, Metering.

Mechanical conditions

1. Abrasion
2. Oxidation
3. Carbonization
4. Any other conditions which may lead to deterioration of functions or lead to lapse of safety.

Electrical conditions

1. Isolation resistance
2. Functioning of RCD detection and Isolation mechanism
3. Compliance to Sanctioned load capacity
4. Any other conditions which may lead to deterioration of functions or lead to lapse of safety.

All the compliance tests should be done in line with requirements mentioned in AIS-138 (Part1) and based on visual inspection wherever applicable.

ANNEX H

Technical information to be submitted by component manufacturer.

| No | Specification |
|----|---|
| 1. | Type – Slow/Fast |
| 2. | Input Specifications : Rated Voltage, Current, Frequency, 1 ϕ / 3 ϕ |
| 3. | IP Degree |
| 4. | Operating Temperature |
| 5. | Dielectric Characteristics |
| 6. | Insulation Resistance |
| 7. | Safety Features |
| 8. | Class - Based on Cable Configuration - Based on Load Capacity |

ANNEX I
(See Introduction)

COMPOSITION OF AISC PANEL *

| Name | Organization |
|--------------------------|---|
| Convener | |
| Mr. A. A. Deshpande | The Automotive Research Association of India (ARAI) |
| Members | Representing |
| Mrs. Ujwala Karle | The Automotive Research Association of India (ARAI) |
| Mr. S Eswara rao | BHEL R&D Hyderabad |
| Mr. Renji Chacko | CDAC Thiruvananthapuram |
| Dr. Z.V. Lakaparampil | CDAC Thiruvananthapuram |
| Mr. Tirath Jani | Electrotherm India Ltd |
| Mr. Atul Gupta | General Motors Tech Center Bangalore |
| Mr. Prabhjot Kaur | IIT Madras |
| Mr. S Sreehari Nagarajan | IIT Madras |
| Mr. Akshay Ahuja | India Smart Grid Forum |
| Mr. Vishwajit Joshi | KPIT Technologies Ltd |
| Mr. Abhay Patwardhan | KPIT Technologies Ltd |
| Mr. T kumar Prasad | Mahindra and Mahindra (SIAM) |
| Mr. Neel Mathews | Mahindra Reva Electric Vehicles (SIAM) |
| Mr. Amit Bharti | Maruti Suzuki India Ltd (SIAM) |
| Dr. Tapan Sahoo | Maruti Suzuki India Ltd (SIAM) |
| Mr. Tarun Aggarwal | Maruti Suzuki India Ltd (SIAM) |
| Mr. Subhash N Patil | Masstech Controls |
| Mr. Sameer K Raje | Masstech Controls |
| Mr. Bhushan R Bharambe | Masstech Controls |
| Mr. Suresh Kalidas | Renault Nissan (SIAM) |
| Mr. Sivam Sabesan | Renault Nissan (SIAM) |
| Mr. D Seshadri | SAE India |
| Mr. Saurabh Rohilla | SIAM |
| Mr. Sandeep B Rao | Tata Consultancy Services Ltd |
| Mr. Manav Giri | Tata Consultancy Services Ltd |
| Mr. Manohar Patil | Tata Consultancy Services Ltd |

| | |
|---------------------|------------------------|
| Mr. Philip Jose | Tata Motors Ltd (SIAM) |
| Mr. Naga Chaithanya | Tata Motors Ltd (SIAM) |
| Mr. Datta Sagare | Tata Motors Ltd (SIAM) |
| Mr. Nushreen Ahmed | Tata Power Mumbai |
| Mr. Suhas Dhapare | Tata Power Mumbai |
| Mr. Arghya Sardar | TIFAC |

* At the time of approval of this Automotive Industry Standard (AIS)

ANNEX J
(See Introduction)

COMMITTEE COMPOSITION *
Automotive Industry Standards Committee

| | |
|--------------------------|--|
| Chairperson | |
| Mrs. Rashmi Urdhwareshe | Director The Automotive Research Association of India, Pune |
| Members | Representing |
| Shri Priyank Bharti | Ministry of Road Transport and Highways (Dept. of Road Transport and Highways), New Delhi |
| Representative from | Ministry of Heavy Industries and Public Enterprises (Department of Heavy Industry), New Delhi |
| Shri S. M. Ahuja | Office of the Development Commissioner, MSME, Ministry of Micro, Small and Medium Enterprises, New Delhi |
| Shri Shrikant R. Marathe | Former Chairman, AISC |
| Shri R.R. Singh | Bureau of Indian Standards, New Delhi |
| Director | Central Institute of Road Transport, Pune |
| Director | Indian Institute of Petroleum, Dehra Dun |
| Director | Vehicles Research and Development Establishment, Ahmednagar |
| Representatives from | Society of Indian Automobile Manufacturers |
| Shri T. R. Kesavan | Tractor Manufacturers Association, New Delhi |
| Shri Uday Harite | Automotive Components Manufacturers Association of India, New Delhi |

Member Secretary

Shri Vikram Tandon

Dy. General Manager

The Automotive Research Association of India, Pune

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